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THE NATTERJACK TOAD IN IRELAND.

BY THE HON. MRS. WARD.

(*With a Coloured Plate.*)

My object in the following remarks on the Natterjack Toad in Ireland is to present to the reader, in a tangible form, a little information which has apparently remained latent for a long time, not reaching the general public, so far as I am aware, and certainly not becoming known to myself till about a year ago, when I learned it in various accidental ways.

A paragraph appeared in a Dublin daily newspaper, the *Irish Times*, on October 1st, 1862, headed "Irish Toads and their use." It stated that the rarer British toad (*Bufo calamita*) is an inhabitant of certain districts in the county of Kerry. "These Irish toads," continued the writer, "are very pretty creatures, utterly devoid of that cold slime and general ugliness which render frogs an object of aversion. They are quiet little beings, and are readily tamed;" and it was added that they would be found very useful in a greenhouse, being expert destroyers of *aphides* and other insects. I did not agree with the writer's denunciation of the frogs; but I was greatly interested in the statement about the natterjack toad being found in Ireland, as it tended to confirm an anecdote which I had heard in England two months previously. I wrote to ask the editor on what authority the existence of *Bufo calamita* in Kerry was stated.

In reply I was referred to the work of Dr. Charles A. Cameron, M.R.I.A., a *Guide to the Royal Zoological Gardens, Phœnix Park*,* where, at p. 46, I read, "The common toad, (*Bufo vulgaris*) is a native of England, but is never met with in Ireland, its place being occupied by the natterjack toad (*Bufo calamita*), which, however, is exceedingly rare, and confined to the county of Kerry." The proprietor of the *Irish Times*

* M'Glashan and Gill, Dublin, 1861.

(Capt. L. Knox) not only presented me a copy of Dr. Cameron's little work containing this information, but, to give me still more substantial evidence on the subject, most obligingly obtained for me a live natterjack toad caught in Kerry. It arrived quite safely in the midst of some moss in a pasteboard box, on October 11th, and thenceforward, till it went some inches underground in November for its winter sleep, it was a pet and favourite in our house. I readily agreed with the *Irish Times* writer's opinion, that it was a "very pretty creature," and appreciated its superiority to the frog; it ran in a brisk, pleasant way, with its body well raised from the ground, and no doubt this might, by most observers, be preferred to the alarming jump of a frog; and its beautiful deer-like eye could not fail to be admired. My drawing, from which the coloured plate is engraved, correctly represents its size, form, and markings, and is taken as it appeared when animated by the sight of a fly or spider. I was told that it could be very easily tamed, and that some toads of this species would run across a table and take a fly from the hand of a person they knew. I could imagine that mine had probably done this, for it seemed very well to understand being fed, and though it would not eat from my hand, it readily walked up to any flies which I placed near it; it would "point" a fly, exactly in the manner of a trained dog pointing a covey of partridges—then it would perhaps make one stealthy step nearer—then the insect would disappear! swallowed by the toad, which caught it with its tongue, as the books inform me; for the utmost I could see, even with close attention, was a sort of red flash about its mouth, but after this, if the fly or spider was large, my toad's head would become, in an extraordinary manner, confused in its outline, its eyes closing, and appearing to sink to a lower level till the work of swallowing was over.

I kept this toad for a while in a common box, with a little lace, or, strictly speaking, "net," stretched over an opening cut to admit air, and with plenty of damp moss inside; but at my leisure I converted a hand-frame from the garden into a "vivarium" for it, furnishing it with some turf and heather, and fastening two pieces of net over the vacant places where two panes of glass had been broken.

The marked success of my inquiries so far, encouraged me to ask more questions, and I proceed to relate the facts which were elicited.

The exact place in Kerry where the natterjack toads exist is around the harbour of Castlemaine, situated at the eastern extremity of Dingle Bay, which (as any map of Ireland, even the outline ones which accompany Railway Guides, will show) is the northern of four or five deeply recessed inlets on the west

coasts of Kerry and Cork. Two headlands will be discerned, nearly facing each other, and forming the division between Dingle Bay and Castlemaine harbour; these are Inch Point and Rosbegh Point, and will frequently be mentioned in this narrative.

The circumstance of the existence of these little reptiles in this district appears to have been first publicly detailed at a meeting of the Dublin Natural History Society on November 5th, 1841, by William Andrews, Esq., president of the society. On that occasion Mr. Andrews presented to the society four specimens of the natterjack toad, and three rock-pigeons, all which he had secured during a ramble taken by him in the county of Kerry during the month of August in that year. He accompanied these gifts with a most interesting lecture, describing the various plants and animals which he had met, in a manner calculated to stir the heart of a naturalist. The report of this lecture is before me; it is contained in a copy of *Saunders's News-Letter* for Tuesday, November 9th, 1841; and Mr. Andrews informs me that the transactions of the society were not otherwise published at that time, which, he says, "may account for the discovery not being mentioned in books of British reptiles."

I will quote his account of the toads at full length—it occurs after his description of the productions and scenery of Brandon Mountain, Ferriter's Cove, the Blasquet Islands, and Cahir-Conree. "Rosbegh Island," he says, "which forms the south-eastern terminus of Dingle Bay, was next the scene of my rambling. There grows the rare and beautiful *Lathyrus maritimus* (*a* of Graham, in Hooker) the only now known locality in Ireland. Several sheltered mounds of sand are completely surrounded and covered by the dense foliage, and enlivened by the purplish-crimson flowers of this handsome plant. Its roots are remarkably strong, and, not penetrating to any depth in the sand, can be traced creeping to the extent of twenty feet. Luxuriating beneath the shade of their broad and thickly-set leaves, the natterjack toad (*Bufo calamita*) reposed. These little animals (inhabitants of heaths and commons in the southern parts of England, and on the coasts of the Solway Frith) abound in the Island of Rosbegh, and also in Inch. They have the thick and squat body, covered with tubercles, the characteristic of toads, with the porous swelling behind each eye, yet they do not express the fetid secretion of *Bufo vulgaris*. The stealthy yet animated action they evince in setting their prey is exceedingly amusing. In their quiescent state their colour appears of a dull olive brown, but when excited their eyes largely dilate, displaying the bright gilding of the irides, and their markings become of a lively yellow, the mesial

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stripe along the back appearing more strongly conspicuous. Flies, grasshoppers, beetles, and the larvæ of insects are their general food, which they take (only when the object is in motion) by darting their tongue with astonishing rapidity and precision. Their note is a pleasing chirp; but in the breeding season at night they keep a continued and confused noise, like to the action of a number of spinning-wheels. Strangers that visit Rosbegh during the bathing season do not like occupying the cottages near to the beach, being alarmed at the nightly pranks of these lively but harmless little creatures.* The peasantry have the greatest horror and even dread of them, and on my expressing my astonishment (at the Dingle side) at the number of those reptiles congregated about Rosbegh, was readily answered [in Irish]—

> "Wild Iveragh of the blue dragons,
> Glencar, in which no corn ever grew,
> And the high and horrid hills to the west of Desmond,
> All which Saint Patrick never thought worth blessing.

"It appears that Saint Patrick in all his visitations through Ireland, never blessed Iveragh with his presence, his nearest approach being to a bridge east of that district, not far from Killorglin. The Iveragh people console themselves by saying that the Saint, standing on the bridge, stretched forth his arms to them exclaiming—

> 'I bless ye to the west of me, and it is as well as if I travelled through.' "

Iveragh, I should explain, is a barony in the county of Kerry, situate immediately to the west of Glanbehy and the mountain of Curragheen, and including the peninsula, or, as it is usually styled, the *island* of Rosbegh, which, as Mr. Andrews states, "was formerly separated from the mainland; but Lord Headley's extensive improvements have converted marshes and sands, that the tide once widely covered, into rich pastures where hundreds of cattle now graze."

At the close of his lecture, Mr. Andrews said that he had received the utmost kindness and attention from the coastguard officers at Dingle and Ferriter's Cove, as well as from the men of the coastguard generally in that district; and this remark leads me to the other pieces of information which I possess, and for which I am indebted to one of the last mentioned officers, Mr. Ross Townsend, now residing at Balbriggan.

Soon after I had received the information conveyed in the old copy of *Saunders's News-Letter*, I happened (craftily) to ask a distinguished Irishman, "Are there any toads in Ireland?"

* I am told by Mr. Andrews that the natterjacks astonished these strangers not only by their whirring noise, but also by actually entering the ground-floors of the cottages, and climbing over the furniture.

"Oh! surely not," he answered, but on reflection added, "by the bye, there must be, for I have seen a whole boat's crew of them." He directed me to a place where I might hear of them, and after some inquiries I made them out in Dublin at No. 20, Molesworth Street.

What a sight, to be sure, with the subject of the natterjack toad in my thoughts! There I saw no less than forty-five of these creatures, cleverly stuffed, mounted in a case containing a well modelled sea, with boats and background; the toads being employed as the *dramatis personæ* in a species of marine entertainment or regatta. I confess to having felt a qualm of sorrow at first seeing them, similar to that with which the "Wurtemburg animals" inspired me in 1851, and especially the comic frogs, which seemed to me to quote Esop, and say, "It is sport to you, but it is death to us," while I felt inclined to answer, "It is *not* sport to me; I like you better alive and well;" but this feeling got over, how interesting to observe the peculiar "mesial stripe" of the natterjack, displayed on every broad back; and how forcibly the abundance in which these creatures are found is set forth by the numbers here congregated, varying from about half-an-inch in breadth to dimensions surpassing those of a full-grown frog. The group belongs to Sir James Dombrain, and the toads, as I afterwards ascertained, were prepared by Mr. Ross Townsend, who rightly judged that this mode of presenting them to view was likely to attract notice to the fact of their occurrence in Ireland.

One of my friends kindly wrote to him, at my request, for some information; this he gave fully in reply, and I shall presently transcribe it from his letters. I have prepared the little map (see coloured plate) especially to illustrate Mr. Townsend's remarks. It is taken from the "General Map of Ireland [scale four miles to an inch] to accompany the report of the Railway Commissioners, showing the principal physical features and geological structure of the country." These particulars, even to the depth of the water in and near Castlemaine harbour, I have copied with a view of presenting as much as possible to the eye.

"You will perceive," writes Mr. Townsend," that the harbour [of Castlemaine] is formed inside the bar by Rosbegh Point on the south side, and by Inch Point on the north. In the circle of this harbour, from Inch Point on the north, round to Rosbegh Point on the south, passing Lack, Castlemaine, Milltown, Killorglin and Cromane, in all these places toads are to be found in great abundance. The soil is generally of a light turf mould, or sand marsh; in both of these they delight to keep, as the soil is easily penetrated, and they can get covering for themselves in the winter." Mr. Townsend goes

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on to say, that Mr. Andrews in his ramble in Kerry had spent some time with him at Lack and Killorglin. "In one of our excursions," he continues, "on a salt marsh on Rosbegh Point, we found the first toad [the place marked by a *red dot* on my map]—at least the first which was known to be such in that part of the country. Mr. Andrews told me that the late Mr. Thompson of Belfast, who was a naturalist of great research, had mentioned the existence of toads in Kerry as far back as 1805; but the best informed of the people of Kerry at the time I speak of—1841*—did not know of their existence, as the country people called them 'Black frogs.'

"The species I am now describing is the natterjack toad; you will see its specific character, as known in England, described fully in Bell's *History of British Reptiles*, published in 1849; but Mr. Bell was not then aware of this species being found in Ireland. The natterjack toad is never found in those localities I have mentioned more than a quarter of a mile from the sea-shore; but all round the harbour of Castlemaine, which you may see is of considerable extent, they are exceedingly numerous, and from the month of April until September they could be gathered in dozens, as they go forth creeping, or rather running from one locality to another; they make a whirring noise during the evening and night, when some thousands of throats are employed at once, and which I have heard on a calm night more than two miles at sea." Mr. Townsend adds, that on one occasion he removed a few dozens of them to a coastguard station, north-east of Dingle, that is to say, some miles west of Inch Point, and though he remained there twelve months, he never could trace one of them, although the soil he selected for them was exactly like that from which he took them.

The simultaneous disappearance and power of concealment exemplified by these toads, correspond closely with some anecdotes given by Mr. Couch in the INTELLECTUAL OBSERVER for September, 1863; and their aptitude for escaping, which Mr. Couch narrates, was proved, I much regret to say, by the little natterjack whose likeness heads this article. It buried itself in November in a mixture of sand and peat (or as we say, turf-mould) which I had carefully prepared for it in a wooden box, over which the hand-frame was placed, the corners of the box being, as I thought, securely stuffed with moss, wedged down with pieces of slate. Nevertheless it escaped; for when its non-appearance in spring caused me to make a regular search for it, first in the box, and then in the whole room, I had the vexation of finding it dead and dried to a mummy in a distant corner.

* 1840 in Mr. Townsend's letter; but the newspaper appears to fix the date in the following year.

The desire for escaping appears to be a constant habitude of the natterjack, and its powers both of burrowing and climbing cause it to rival Baron Trenck in the success of its endeavours. Mr. Andrews kept some specimens for years in his garden at Rathmines, near Dublin, and has observed that nothing but high walls, with deeply laid foundations, will avail to secure them. Three or four natterjacks will assist three or four more to climb by generously allowing their shoulders to be used as ladders: these creatures piling themselves one on another, like Chinese tumblers, and actively holding on to the smallest inequalities of the wall.

Mr. Townsend concludes his letter by repeating the legendary story of St. Patrick, which he gives to nearly the same effect as Mr. Andrews did, adding, however, that the persons who told it to him had no idea that toads inhabited their neighbourhood. But, surely, we need not complain of the exceptions which present themselves to the non-existence of reptiles in this Green Isle. If the word of promise in this matter be broken to the ear, surely it is fulfilled to the hope; we have no colony of snakes, no lurking adders, although we now and then meet with the sand lizard; are plentifully supplied with the frog and smooth-newt, and possess in Kerry—and possibly elsewhere in Ireland—an isolated party of the harmless NATTERJACK TOAD.

PHOTOGRAPHIC PROCESSES.*

BY J. W. M'GAULEY.

IT is not our purpose to enter into the minor details of photography; we shall content ourselves with noticing the characteristic features of the various processes, remarking, once for all, that each of them may be modified in a great variety of ways.

The Daguerreotype Process. A silver plate of the required size, having been most carefully cleaned, is iodized, or bromo-iodized, by the exposure of its silvered surface to the vapour of iodine, or of iodine and bromine; it thus acquires a golden colour. Having been then placed in the camera and exposed to light for a length of time, varying with the state of the atmosphere, it is submitted to the action of the vapour of mercury, which brings out a picture that was before invisible. The silver salts which have not been decomposed by the action

* This is the second article of a series. The first, on The History of Photography, appeared in No. 27, April, 1864. The third and concluding paper will be given at an early date.

of light in the camera, are then removed by a strong solution of common salt, or a weak solution of hyposulphite of soda, which takes away the golden tint; and finally, the plate is washed with hot distilled water. If the exposure in the camera is allowed to exceed a certain limit, the mercurial vapour will bring out a negative, instead of a positive picture; since a certain amount of actinic action gives to the iodide, etc., of silver a power of condensing the mercury, while a greater amount takes that power away.

Process with Paper. A very simple process consists in soaking paper of a suitable texture in a solution of common salt, drying it in blotting-paper, and then brushing it with a solution of nitrate of silver. If the paper is required to be very sensitive, iodide of potassium is substituted for the common salt; and if extremely sensitive, bromide of potassium is used instead of either. The relative amounts of the salts employed is of great importance. After exposure in the camera, the picture is fixed with hyposulphite of soda.

The Calotype. The paper is washed with nitrate of silver, and then dipped in a solution of iodide of potassium: in this state it is unaffected by light, but it is rendered highly sensitive by washing with a solution of nitrate of silver, to which acetic acid and gallic acid have been added. When removed from the camera, the picture will gradually develop itself in the dark; but it is brought out at once, by gallo-nitrate of silver and heating at the fire. It is fixed with hyposulphite. Pictures obtained by this and similar processes are *negative;* positives are "printed" from them, by placing them in contact with sensitized papers, in a glass frame, and transmitting light through them, for a sufficient time.

Albumenized Paper. Paper which has been carefully coated with albumen on one side, and dried, is washed on the albumenized surface with nitrate of silver. After exposure in the camera, it is fixed in the usual way.

It has been found that the coating of albumen, containing the picture, may be removed from the paper, by steeping for a few moments in concentrated sulphuric acid, or in a concentrated solution of chloride of zinc, and washing carefully with water. The albumen then resembles an animal membrane, and may be placed on any other surface.

The natural tone of a picture on paper is very disagreeable: this is corrected by the *toning bath,* which consists almost essentially of chloride of gold, mixed with one or more other salts. Chloride of gold and bicarbonate of soda constitute the mixture very commonly employed. The toning bath should deepen the tint to a blue, a violet, or even a black, and it may be used either before or after fixing. The dearness of gold

has caused many attempts to substitute other substances for it: of those which have been tried, chloride of platina with acetate of soda gives the best results—it is nearly as effective as chloride of gold.

Albumenized Glass. A combination of several processes has been found most successful with albumen on glass. The albumenized plate is washed with a weak solution of nitrate of silver to which alcohol has been added, then with a mixture of protoiodide of iron, and afterwards with a strong solution containing nitrate of silver and acetic acid. After exposure, it is developed with protosulphate of iron, and fixed in the ordinary way. Albumenized glass, usually very slow, is by this method rendered extremely sensitive.

Waxed Paper. Suitable paper is carefully saturated with liquid wax, the excess of which is removed by blotting paper, and a moderately hot smoothing-iron. It is then immersed, for a considerable time, in a solution containing iodide and bromide of potassium, after which it is dried. When required to be used, it is sensitized with nitrate of silver and acetic acid: it is developed with a mixture containing gallic acid and nitrate of silver, and fixed with hyposulphite.

Moist Collodion Process. Common gun cotton is almost entirely dissolved by a mixture consisting of about nine parts ether and one alcohol: the solution is *Collodion*. *Alcoléne* is a collodion containing no ether. It is obtained by dissolving a gun cotton which has been prepared with 100 parts by weight of concentrated sulphuric acid and 90 parts nitric acid, density 1·4 in alcohol, spec. grav. 0·803, and diluting the result, a thick gummy mass, with absolute alcohol, having an iodide in solution. If weaker acids are employed ether will be required for solution of the gun cotton. The best iodide for preparing a quick and stable collodion is that of cadmium; almost all others colour the collodion, and therefore diminish its sensibility.

A perfectly clean glass plate having been coated with the iodized collodion, which is allowed to solidify, but not to become dry, it is immersed in a solution of nitrate of silver, and then placed in the camera. The picture is developed with a mixture of pyrogallic and acetic acids, diluted with water, and is fixed in the usual way.

Protosulphate of iron may be used in the developing mixture, or—which is very much better—double sulphate of iron and ammonia, instead of pyrogallic acid; if formic acid is substituted for the acetic, the rapidity is augmented, and the picture is rendered more intense. Very good results are obtained if the picture is developed with protosulphate of iron, and intensified with pyrogallic acid and nitrate of silver, before the fixing or, if there is a tendency to fogging, after it.

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Collodion negatives may be obtained with less than half the ordinary time of exposure by plunging the plate, after it has been sensitized with the nitrate of silver, into a concentrated solution of acetate of silver, and developing with pyrogallic acid.

If, after developing a collodion negative as much as possible by the ordinary method, a solution of sulphuret of potassium and a solution of protosulphate of iron are poured alternately upon it, water being used abundantly in washing it after each solution is employed, it will become so opaque as to be absolutely black and white.

Collodion proofs may be developed positive, by means of an alcoholized solution of sulphate of iron containing acetic acid and nitrate of potash, which makes the lights of a dead white; or with an alcoholized solution containing less iron and acetic acid, but nitrates both of silver and potash and nitric acid, which gives the lights a brilliant metallic appearance, The free acid in each mixture tends in a special manner to preserve the shadows. Without the alcohol the mixture would not run freely over the plate. Cyanide of potassium is used for fixing. The presence of a small quantity of copper in the sensitizing bath used with the paper for positives, causes it to afford vigorous and effective pictures from feeble negatives, but does not answer so well with good negatives. As, however, it renders the process tedious, it is objectionable to the professional photographer. If, after developing, the plate is drained, and coated with glycerine, it may be left for some days without being finished. The glycerine prevents the oxidation of the iron, and increases the adhesion of the collodion to the glass; it has the property of continuing moist, and is easily removed with water.

Dry Collodion Process. The glass plate having been coated with collodion, sensitized with nitrate of silver, and well washed, it is brushed over with a bromo-iodated solution of albumen, which preserves it from the decomposing action of light, so that it may be kept for two years or more. It must be sensitized anew at least one or two days before being used. Dry collodion requires four times as long an exposure in the camera as moist.

A preparation of malt, of malt and tannin, or of tannin and glycerine, has been used with great success instead of the albumen. Also ammonia has been employed with excellent effect in the development of dry collodion negatives; the time required, both for exposure and development, being greatly shortened. Ammonia, for some unknown reason, has no effect, occasionally: the development is effected in such cases with caustic potash.

Photography, with Textile, etc., Fabrics. Having been brushed over with a moderately thick mixture of Spanish white and alcohol, they are allowed to dry, after which they are carefully polished with cotton. Thus prepared, they may be treated like positive paper, and will give as good pictures.

Carbon Process. This has for its object a replacing of the salts of silver by carbon in an impalpable powder, which is imprisoned in a sensitive coating. It is founded on the fact that the persalts of iron communicate to organic matter, such as albumen, gelatine, or gum, an insolubility which ceases, under the influence of light, in presence of tartaric acid. The latter, in reducing the ferric compound, restores the natural solubility of the organic substance, and allows both it and the impalpable powder with which it has been combined to be washed away, in proportion to the action of the light, so as to reproduce on paper which has been coated with the mixture, all the varieties of light and shade. Gelatine has been found to answer best for the process. If only the under surface of the coating is rendered soluble, the parts containing the middle shades will be carried off in the washing, as well as those corresponding to the bright lights; this is prevented, either by causing the light to strike the outer surface first, or by modifying the details of the process. The means of attaining these objects have been well treated, in a paper read before the Photographic Society of Scotland, in December last, by Mr. Blair, of Perth. The fixation of the picture is effected by removing the ferruginous compound with acidulated water; and it is rendered still more permanent by means of alum or corrosive sublimate. The process has not yet produced results at all comparable to those obtained with the salts of silver.

The Chrysotype. Paper is washed with a solution of ammonia-citrate of iron, and dried. After exposure in the camera, the faint image then perceived is brought out strongly by washing with a neutral solution of gold, and is fixed by means of water acidulated with sulphuric acid, and subsequent treatment with bromide, or, which is better, iodide of potassium.

The Aurotype. Paper is washed with protocyanide of potassium and gold, then dried. It will now darken very rapidly when acted on by light, and the blackening continues in the dark. Several combinations of gold and cyanogen may be used.

The Platinotype. If a ferrocyanide of potassium and platina is formed, by mixing a boiling solution of chloride of platina, which is as neutral as possible, with a saturated solution of cyanide of potassium, and paper is washed with it, long continued exposure in a camera, during sunshine, will cause a faint impression to be produced; and washing with a solution of proto-nitrate of mercury changes this into a delicate

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picture. But, whatever may be the details of the process employed, a platinotype slowly vanishes, even in the dark—though, in some cases, it gradually reappears.

The Catylissotype. Paper is brushed over with a mixture consisting of syrup of iodide of iron and tincture of iodine, and, when dried with blotting paper, is washed with nitrate of silver. After exposure, nothing is perceptible; but a picture gradually developes in the dark. The name of the process is due to the supposition that, when the silver salt has been slightly affected by the light, a catalytic action sets in, and extends itself to the salts of iron.

Enlarging of Images. The megascope, invented in 1780, is used to produce large from small proofs; thus, to obtain from a microscopic negative on glass, a portrait of the natural size. It never gives an agreeable picture, but skilful retouching may diminish its imperfections. The solar microscope answers well for the same purpose; the negative being placed in the focus of the objective, and the sensitized paper on a screen in a darkened room. The electric light may be used, but solar is preferable.

Heligraphy. This is understood to comprise the effects produced by light on non-metallic substances; but is applied especially to a development of the discoveries of Nicephorus Niepce, which has become very important, since it affords a means of obtaining impressions from metallic plates and lithographic stones. Niepce used asphaltum, but Daguerre remarked that all bituminous resins and the residues of essential oils are decomposed by sunshine. Vegetable juices, also, are sensibly affected by it. In the process employed by M.M. Lemaitre and Niepce de Saint Victor, a carefully cleaned plate of polished steel is coated with a solution of bitumen of Judea in essence of lavender, and dried by heat. A transparent positive is then placed over it, and after the bitumen, which has been rendered soluble by sufficient exposure to light, has been dissolved off by a mixture of rectified oil of naphtha and benzine, it is washed and dried. The plate is next acted on by nitric acid diluted with water and mixed with alcohol, and, having been again washed and dried, it is covered with finely powdered resin, and heated. This hardens the bitumen, and in the shadows forms granulations which give good impressions with ink.

If a picture is obtained with bitumen, by the method of Niepce, and the plate is then placed in an electrotype apparatus, copper will be deposited upon it, on connecting it with the negative pole; but it will be corroded in the lights, on connecting it with the positive. A plate may, therefore, be obtained which will give impressions like an engraved copper-plate, or like an engraving on wood.

Photolithography. The stone is covered with a varnish consisting of bichromate of ammonia, water, and albumen, and when dry is exposed to light, under the engraving, etc., which is to be copied. Nothing is visible until the surface of the stone is washed with Marseilles soap, which removes the soluble portions—those where no insoluble oxide of chrome has been formed, and which, being allowed to act for a sufficient time, slightly hollows the stone wherever its surface has been laid bare. If it is then wetted and inked, as for lithography, the ink enters the hollows, but it is repelled from the parts in relief, which are to form the lights. The engraving, etc., is not reproduced in reverse, nor is it injured by the process of preparation.

Barreswil's method consists in covering the stone with a solution of bitumen of Judea in ether, which forms, not a varnish, but a granulation. A negative is laid on this; and the portions of the bitumen rendered soluble by exposure are washed off in the usual way. Impressions may then be taken from the stone; and, for some time, each is better than the preceding one.

Zinco-photography. Paper is prepared with bichromate o potash and gelatine, and, after having been exposed under a negative, is covered uniformly all over with ordinary lithographic ink; it is then washed with gum water, which removes the unaltered gelatine, and leaves a well-inked positive picture. This is transferred to a properly grained zinc plate, by pressure; after which the process is that ordinarily used with zinc.

Photographic Engraving. Dilute nitric acid dissolves the silver from a Daguerreotype, without acting on the portions covered with mercury. In this way may be obtained a plate which will afford a few tolerable impressions. A great improvement is effected by rubbing grease into the cavities formed by the acid, gilding the prominent parts by the electrotype process, and then deepening the hollows with acid. The plate must then be finished with the burine, which of course injures its truth as a photographic product.

Photography in Relief. A sheet of gutta-percha is coated with a mixture of gum arabic and bichromate of potash, and when dry is exposed in the camera. The parts of the gum which have thus been rendered soluble are then washed away with water; after which the sheet is dried. It is next held horizontally, the gummed side being under, and, the corners being pinched up so as to form a kind of rectangular trough, hot water is poured upon it. This causes the gutta-percha to become prominent wherever the gum has been removed; and thus the lights appear in a relief, which is unfortunately too great.

General Coloration of Photographs. Besides the care usually

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bestowed on toning, the uniform tinting of photographs has received considerable attention, as a means of improving their appearance. This is brought about in various ways. If, before exposure, a paper positive is placed for a short time in a solution of uranium, then, on being taken out of the camera, is washed for a few seconds in water at a temperature of from 122° to 140° Fahr., and, immediately afterwards, is plunged into a solution of red prussiate of potash, it will soon acquire a fine red colour. Being now dipped in a solution of nitrate of cobalt, and dried at the fire, it will become green; and this colour is fixed by immersing in a solution containing sulphate of iron and sulphuric acid, washing with water, and drying at the fire. If a solution of prussiate of potash is used instead of that of uranium, and a solution of bichloride of mercury, saturated in the cold, after the paper has been taken from the camera, followed by a solution of oxalic acid heated to from about 122° to 140° Fahr., the colour will be a beautiful blue.

Heliochromy. Among the various processes used by Niepce de Saint Victor for the reproduction of colours, the following were found to be the most effective:— A plate, like that used for the Daguerreotype, is immersed for ten minutes in a solution of chloride of copper, or of iron, saturated to a degree suited to the reproduction of the mean colours of the spectrum, and then gently heated with a spirit-lamp; if light which has passed through a transparent coloured picture is now thrown upon it, the various tints will be produced, but will vanish immediately. If, however, the bath employed consists of half proto or sesquichloride of iron and half sulphate of copper, the colours of objects are reproduced with great vividness, with the exception of yellow; and even this is obtained by using a bath of hypochlorite of soda, containing some alcohol and raised to a temperature between 158° and 176° Fahr., stirring the plate about in the mixture, until it is nearly black, then washing with water, and drying with the flame of a spirit-lamp. Before exposure, and while still lukewarm, the plate is coated with a varnish which consists of dextrine and chloride of lead, and dried by heat. This varnish causes the colours to appear with great brilliancy, and brightens the white ground, on account of the chloride of silver being bleached by the chloride of lead. When a bath consisting of dentochloride of iron and sulphate of copper has been used, *fused* chloride of lead prepared directly from the metal must be employed; but, when a bath consisting of hypochlorite of soda, *unfused* chloride of lead, that it may neutralize the action of the alkaline solution, and tincture of benjamin of Siam is to be added to the varnish. After the picture has been obtained, the plate is to be heated, gradually, to the highest point short of carbonizing the organic

matter. This, if the whole thickness of the sensitive coating has been acted on by the light, intensifies the colours, otherwise it changes the blues to violet, and the black to red. It renders the tint so permanent that, when the iron and copper bath has been used, they are not destroyed by less than ten or twelve hours' exposure to diffused light; and when the soda bath, not by less than three or four days' exposure to the bright light of summer. The colours, in these processes, make their appearance one after another. Those of natural objects, on account of the white light always mixed with coloured rays, are more or less vitiated; and when the hues of the spectrum are reproduced, a disagreeable violet shade is found to pervade them all. The binary colours, or those formed by a union of two, are decomposed by heliochromy; hence the green of the emerald will be reproduced by it; but the green formed by a mixture of chrome yellow and Prussian blue, will afford only blue. It has been asserted that the colours may be completely fixed by alloxan; but this requires confirmation.

Encaustic Photography. A thin glass plate is coated, in the dark, with a mixture consisting of bichromate of potash, honey, white of egg, and water, and dried in a gas stove. It is next placed under a positive, in a copying frame, which produces upon it a weak negative. Pulverized enamel is then rubbed on with a soft brush, until a good positive is produced, which is fixed with alcohol, to which a little acetic or nitric acid has been added; when the alcohol has evaporated from its surface, it is put horizontally into a dish containing water, and left there until the chromate is dissolved out. The picture in enamel remains, and, having been properly dried, is put into the furnace.

A CHEAP OBSERVATORY.

BY FREDERICK BIRD.

THE writer of this article was for several years of the number of those observers who ply their starry occupation for the most part in the open air, and can well sympathize with his brethren under the many difficulties with which their pursuit of knowledge has to be carried on. He commenced his career by casting a metallic speculum, and fabricating a telescope with his own hands. His out-door station was at a wooden turn-table, having around it a circular bricked pavement, and many were the delightful hours there spent in hunting up nebula and the double stars.

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Out-door observation has, no doubt, its advantages. Telescopes are generally understood to work best when the object-glass or speculum has attained the temperature of the surrounding air. And certainly those who wish to familiarize themselves with the constellations, and the names and peculiarities of their leaders, as the more prominent stars are called, will get on much better in the open air, with the whole heavens before them, than when looking through the narrow opening of an observatory.

But when the higher purpose of close telescopic scrutiny is the intention, then the shelter and many conveniencies of the observatory are indispensable.

So immensely remote are even the nearest of the heavenly bodies that for the most part we know little or nothing of the nature of their surfaces. The pencillings on their discs of lines, streaks, or spots, arising from clouds, oceans, mountain chains, or other unknown peculiarities of their structure, are by the mere effect of distance reduced to the utmost delicacy, and require not only the best optical means to reveal them, but also that the observer himself should be placed in an easy posture, and be perfectly free from bodily inconvenience.

The most interesting part of an amateur astronomer's work consists in observing such details, or in picking up minute objects amongst the fixed stars, measuring the interval separating double stars, determining as nearly as may be angles of position, and watching for variation—*one of the most useful matters to which an amateur can devote his attention*—occasional sketches of lunar craters under different degrees of illumination, solar spots, as the great orb rotates and brings them into view; noting the occultations of stars by the moon, with a view to decide the question, yet unsettled, of a lunar atmosphere; and many other niceties of observation which not only invest his labours with interest, but impart to them a real value. To do any of these things, however, effectively in the open air, with one's telescope agitated by the passing wind, and a body shivering with the cold, is clearly next to impossible.

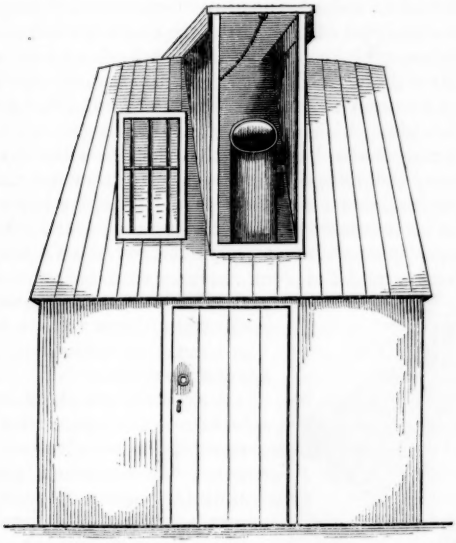
This remark then leads to the main object of the present article, namely, to describe a "cheap observatory," which the writer has recently erected for himself, and to show that at a very moderate outlay an amateur, who has the convenience on his premises for the erection of such a building, need not to remain destitute of it.

He was led to the erection of an observatory chiefly to afford greater protection to a fine silvered glass speculum, of twelve inches aperture, some account of which appeared in a former number of the INTELLECTUAL OBSERVER. Since then he has completed a much finer one, of a similar aperture, having a focal

length of nine feet, fixed in an iron tube, and mounted on a fine mahogany stand by the late Charles Tulley.

The observatory is erected on the summit of a sand rock, about sixty feet above the surrounding surface, and within eighty yards of the Great Western Railway. The weight of the rock is fortunately sufficient to absorb all tremors from the passing trains, from which when below there was a constant annoyance, tremors being often perceptible after the train had passed out of hearing.

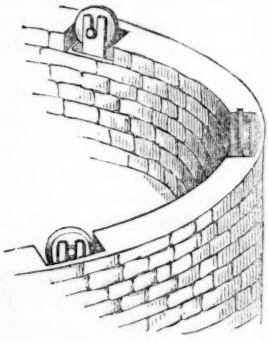
The aspect of the observatory is nearly all that could be desired, being completely open except in the extreme north, and even there a view of all objects 8 deg. below the pole can be obtained. The exterior of the building with the front shutter taken down is represented by the following sketch.



It consists in the first place of a circular bricked building carried up exactly five feet high, with a low entrance door-way sufficiently wide to admit the telescope stand. And as economy in the materials and every part of the erection required to be strictly observed, the bricks of which the building is composed were old ones that had done duty for several years before, on the same spot, in the shape of a summer arbour. They were pulled down, cleaned, and reset, and being for the most part

broken and fragmentary, were all the more suitable for turning the sharp curve. The walls are nine inches thick throughout, and the interior diameter of the enclosed space nine feet. Two courses from the top, and at equal intervals, are inserted six slabs of stone, to which are securely bolted the cast-iron chairs carrying the flanged wheels, on which the roof was intended to revolve. The wheel and its axle, and the chair, were cast in separate pieces, and required, therefore, only two very simple patterns. The wheels required turning in a lathe to render them true, but the chairs were trimmed up and finished with a file, and the whole when completed cost exactly 22*s*. In setting the wheels great care was bestowed to range them accurately in a circle, and to ensure this each one as set was tested by a wooden radius working on a firm support at the centre. They were also accurately levelled, the one from the other, and when finished, the upper bearing edge stood half an inch above the level of the final ring of brickwork.

The diameter of that part of the wheel which carries the weight is four inches. The flange extends beyond this three-quarters of an inch more, and the surface of the bearing part is one inch wide, which allows for slight irregularity in the iron circle. It might also be mentioned that in order to do away with friction, the flange is not perpendicular to the bearing surface, but reclines away from it, hence the edge of the iron ring comes in contact with the flange only at its base. The wheels may appear rather small, but they are found to answer most perfectly, and the roof moves with freedom. Out of the six wheels it rarely happens that more than three take a bearing at one time, but when one leaves off another begins.



A sketch of their appearance when *in situ* before the roof was put on is here given. We next come to the wooden part of the building, namely the roof. Here again economy interposed and forbad all the woodwork being planed, so it was used up simply as it came from the saw.

The framework of the roof is made up of two circles, four vertical standards, and two cross beams. The circles are both of elm, and were cut in segments from boards one-and-a-half inches thick, they were placed end to end on a level floor and united by other segments only an inch thick, these were laid across the joints, and all firmly united by screws.

The larger circle is ten feet and the smaller eight feet in diameter. The latter was mounted over the former on the four uprights, and the cross beams laid in their places and well secured.

The sides were then covered in with light deal boards, the edges of which being ploughed and tongued the joints were rendered quite close and perfect, at the same time they were securely nailed to the elm circles above and below.

For the greater comfort of being well inside the building when observing, instead of the front shutter being formed on the sloping surface, it was thought better to carry the cross beams, on one side, some distance beyond the edge of the roof, to be met by uprights standing vertically on the lower elm circle, the intervening surface being boarded up and forming a kind of porch. A window also was inserted on the right-hand side of the porch, for the convenience of light in the day time. The top surface of the roof and sliding shutter were boarded over, and then covered with zinc, which was also carried a few inches down the sides, rendering all perfectly watertight. The sliding shutter referred to moves on rollers between two strips of timber laid across the top of the building under the zinc, and is opened or closed by means of a continuous cord, the ends of which are attached to the opposite ends of the shutter and pass over appropriate pulleys, so that it can be completely controlled without the necessity of going up to it. The upright shutter is removed entirely when a front view is required.

It now merely remains to state that a facility for motion was given to the roof by attaching an iron ring to the lower elm circle. It was formed out of pieces of flat bar iron two inches wide and about four feet long each, holes were drilled through and counter sunk, and the bearing edge made straight, the bars were then heated and bent to the required curve, they were put on end to end, but not quite in contact, in order to leave room for expansion, and very firmly screwed to the circle. The roof was then lowered down, and when the iron edging rested on the wheels, the whole fabric was put in motion with a very slight effort. The movement was rendered still easier by several convenient pushing handles afterwards inserted, and a good supply of grease to ease the friction. A few minor details remained to complete the structure, such as painting inside and out, a bricked floor laid upon a thick bed of ashes, a convenient shelf a foot wide carried completely round the building above the large elm circle, from which depended a valance of oil baize intended to hide the wheels and also to check the draft. The building has now been in use for several months, and nobly stood the ordeal

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of the great wind storm which swept over the country not long since, the only mishap being a flight of the top shutter which was left unfastened.

The comfort and convenience of the building has been found very great, and the performance of the specula immeasurably superior to what it ever was when they were used in the open air. They are left permanently in the tube shut up with tin covers, fitting closely to the cells in which they are mounted, and further protected from damp by a bag of sawdust which has been steeped in a saturated solution of the chloride of calcium and afterwards baked thoroughly dry. Thus protected their surfaces retain all their original splendour, and are reflective in the highest possible degree. On reckoning up the entire cost of materials and workmanship, it was found not to exceed the very moderate sum of £14.

Should any observer of the heavens, reading this account of a cheap observatory, be resolved to get under the shelter of a revolving roof, it would afford the writer pleasure to aid him by any explanations and suggestions not already mentioned in the foregoing article.

General Cemetery, Birmingham.

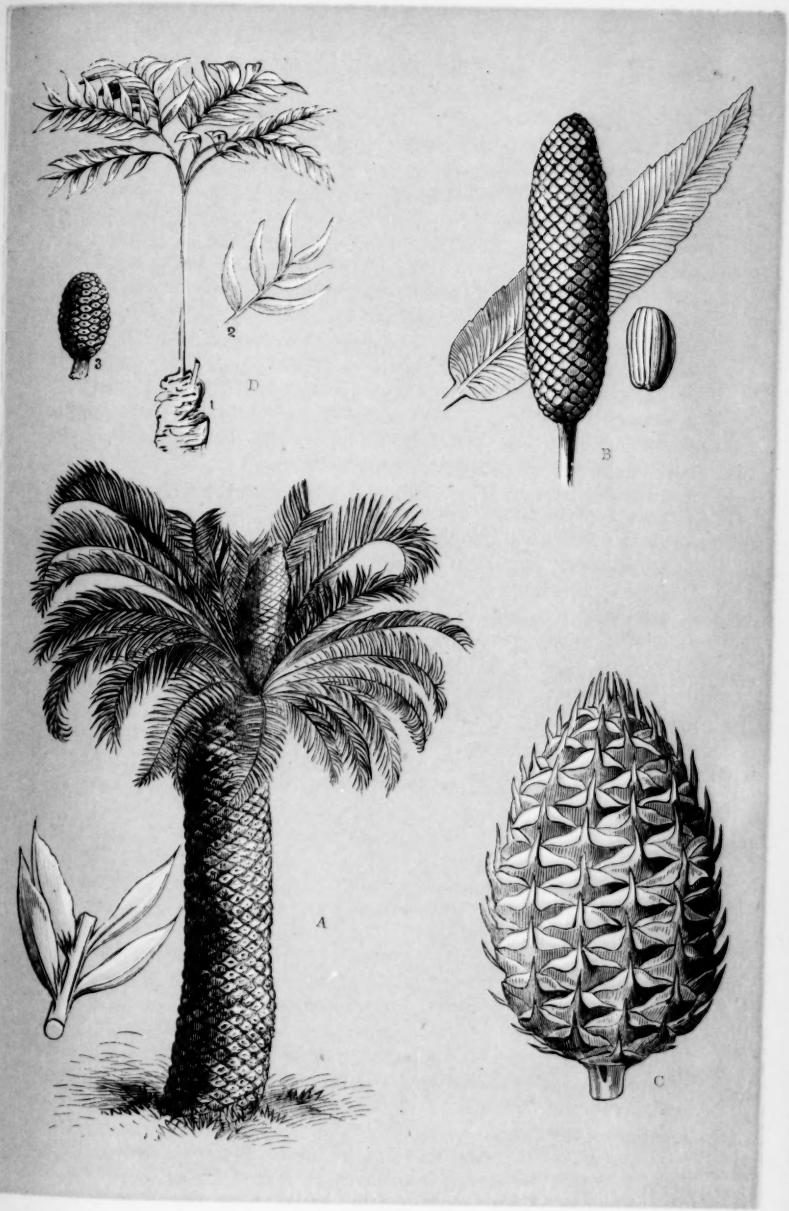
CYCADS.

BY JOHN R. JACKSON,

Curator of the Kew Museum.

(*With a Tinted Plate.*)

There is something strange and peculiar about the cycads—something wierd and pre-Adamitish about their very appearance—which fixes our attention, even at the first glance, and the more closely we examine into the history of these plants the more interesting does it become. In the whole range of the vegetable productions of our globe it would be difficult to select a group of plants to which more of interest is attached. There are not very many of them, perhaps not more than 70 or 80 species, at present existing. Their geographical range is somewhat extended, for we find them in Africa, in America, the West Indian Islands, and in Australia; they are the scattered remnants, the living representatives of a bygone flora. They form a little family circle, completely isolated from the remainder of the vegetable world. They have no close ties of relationship connecting them with any other group of plants, although possessing external resemblances to several. So peculiar and



CYCADS.

Fig. A. Encephalartus Caffer, Lehm.

Fig. B. Male cone of Stangeria paradoxa, Moore. With seed and leaflet quarter natural size, showing venation.

Fig. C. Female cone of Macrozamia spiralis.

Fig. D. Bowenia spectabilis, Hook. 1. General appearance of plant. 2. Form of leaves. 3. Male cone half natural size.

well marked are the characters by which they are known, that having once become acquainted with them, the family likeness is at once recognized.

It is very strange that so remarkable a family, and one whose history is fraught with so much of interest, we might almost say of romance, has never yet found a biographer; no one has taken the subject in hand, and any one wishing for information concerning the cycads must seek for it in brief notes and passing allusions in a hundred different works. No man has undertaken the duty of introducing this family to the British public. That pleasant task has fallen into our hands, and we believe that the readers of the INTELLECTUAL OBSERVER will find something to interest them in the subject of our paper, if not in the manner in which it is treated.

In their cylindrical, undivided stems, surmounted by a crown of foliage, the cycads resemble palms. A good idea of the general habit of the family is shown in Fig. 1, which is a sketch of *Encephalartos Caffer*, Lehm., from a fine specimen growing in the Royal Botanical Gardens, Kew. It will be seen that the stem is undivided, growing only at the apex, and that the lower parts are marked with the scars of the old leaves. In exceptional cases the stems are divided dichotomously. In this again cycads resemble palms, for there are one or two examples of forking stems even among the palms, as Hyphœne for example. In the germination of their seeds, too, there is a similarity between them; but then, again, if we look at the venation of the leaflets of their pinnate fronds we should be inclined to think there must be some relationship with ferns. The arrangement of the veins is precisely that found in the free-veined ferns, as shown in Fig. 2; indeed, when the fronds of this plant were first sent to this country, without either stem or fruit, they were believed to belong to that family, and the plant was, by Kunzé, a first-rate authority upon ferns, published as a species of Lomaria.

The most characteristic feature of the ferns, and one which most persons would look upon as being a distinctive mark of the family, is the gyrate vernation of their fronds; that is, their being coiled up, like the head of a crozier, in their young state. But this we find is also a character observed in the majority of cycads. While their habit of growth resembles the palm, their venation and vernation is, to all appearance, fern-like; but their floral organs and their fruits, which are, of course, the most important parts, give us the resemblance of a third great natural order—*Coniferæ*, the fir-tree tribe. The flowers are unisexual and without floral envelopes (*achlamydeous*). In the male cones the one-celled anthers are scattered in sessile clusters over the lower surface of the scales. The anthers split

up longitudinally. The fruit is produced in cones, closely resembling in many cases those of various kinds of conifers (see Figs. 2 and 3). The size of their cones varies much with the different species, in some, as those of *Encephalartos*, they are of immense size, frequently measuring two to three feet in length. The hard-cased nut-like seeds are either arranged along the sides of altered leaves or scales as in *Cycas*, or at the base of the peltate scales, as in *Encephalartos*. The seeds of *Cycas* are as large as a walnut, while those of *Stangeria paradoxa* much resemble hazel-nuts.

With such peculiar features as those above described, it is not to be wondered at that the early botanists were much puzzled as to the affinities of cycads. Thus we find that Linnæus himself was at first inclined to class them with palms; but he subsequently changed his opinion, and, with Adanson and some other authorities, gave them a place among ferns. After considerable discussion upon this difficult subject, M. Richard came to the conclusion that they should constitute an order by themselves, under the title of *Cycadeæ*; but he still retained them as near allies of the two former orders, giving them, in fact, a place intermediate between palms and ferns. Subsequent researches have proved that though they resemble these natural orders, yet they have no true affinity with them. The cycads are now placed in what is no doubt their true position, that is among Gymnogens, a class intermediate between Endogens and Exogens, and associated with conifers, taxads, (yews), and joint firs, from each of which orders, however, they are totally distinct.

The cycads may claim a high antiquity, for they certainly existed in considerable numbers in this country during the Oolitic period, as their remains well preserved in the strata at Portland abundantly testify, and they may have existed even earlier. It is not at all improbable that some of the fronds found in the Carboniferous strata, and usually looked upon as ferns, are in fact cycads. The texture of the fronds was evidently thick and leathery; a characteristic of the family we are speaking of, but much more rare among ferns. The essential character of the flora of the Lias period is the predominance of Cycadeæ, says Dr. Balfour; we find in strata of that age many species of Cycadites, Otozamites, Zamites, Ctenis, Pterophyllum, Nelsonia, and other allied genera. There are few flowering plants which can be traced further back. Cycads formed, doubtless, part of the food of that mighty reptile, the Iguanodon, which trod this earth when the Wealden beds were deposited. The family must have made an important part of the flora of this country at that remote period; but with the changes of climate and circumstances, brought about during the great

length of time which has since elapsed, the cycads have been driven southward, until not a single species is now found in Europe. They are not alone in this respect, for palms and gigantic tree ferns flourished here too. Only one or two species of palm now exist north of the Mediterranean, and no example of a tree fern. The genus *Banksia*, which we now look upon as being more characteristic than perhaps any other of the Australian flora, was, there is reason to think, at one time, a native of this country. We cannot be surprised therefore to find that the cycads have all emigrated: let us see where we find their descendants settled in our own day.

The geographical distribution of this family is not confined within such narrow bounds as was supposed a few years ago, many new species, and new localities for old ones, have been recently discovered. They are perhaps more plentiful in South Africa than in any other part of the world. Mr. Bunbury, writing in the *London Journal of Botany*, says that Zamias are among the forms of vegetation that characterize the eastern parts of the colony of the Cape of Good Hope, especially the great tract of thicket extending along the Caffir frontier. It was formerly supposed that they were not to be found in the regions of tropical Africa, but the researches of Barter upon the Niger, and Gustav Mann upon the west coast, prove this to have been a fallacy; some fine cones collected by these two botanists now enrich our national collection at Kew, as well as some specimens sent by Dr. Kirk of the Livingstone Expedition. Among the species most plentiful in South Africa are *Encephalartos Caffer, E. horridus,* and *E. pungens.* Cycads are also found in Mexico, the East and West Indies, in Madagascar, the warmer parts of Asia, and some of the South Sea Islands. The recent researches of Dr. F. Mueller of Melbourne, and Mr. W. Hill of Brisbane, have added much to our knowledge of the Australian forms of this family. One most interesting species, for the knowledge of which we are indebted to the latter botanist, we must mention. It is *Bowenia spectabilis* (Fig. 4), of which an admirable figure by Mr. W. Fitch was published in the *Botanical Magazine* (T. 5398). We borrow the following remarks from Sir William J. Hooker's description of the plant, published in that valuable work:—"The discoverer of this singular plant was the late Allan Cunningham, from whom we received, upwards of forty years ago, a portion of a frond, collected at the Endeavour River (lat. 15 deg. S.) in 1819, and referred by him provisionally to *Aroideæ* (*Dracontium polyphyllum* M.S.) Nothing, however, was known further of it till Mr. Walter Hill, the zealous and able head of the Brisbane Botanic Gardens, re-discovered it in Rockingham Bay, and sent a young living plant, with full-

grown dried leaves, and a male cone, to the Royal Gardens, Kew, in 1863. From these materials the plate and description have been made, and, in accordance with Mr. Hill's desire, as well as our own, we have attached the name of the present enlightened Governor of Queensland (Sir George F. Bowen, G.C.M.G., Captain and Governor-in-Chief) to the genus, in recognition no less of that officer's position as Governor of the district of Australia in which the plant was found, than of his liberal encouragement to botany, and of Mr. Hill's exertions in particular. As a genus, the most prominent character of Bowenia is the compound leaf, its general characters (all but shape), texture, and venation; the leaflets do not differ from those of Macrozamia, and are so very similar to those of some West Indian Zamias that it is difficult to distinguish them generically, except that in Bowenia the leaflet is decurrent by the petiole, and not articulate with the rachis. The habits of growth, caudex, etc., entirely accord with that of the South American Zamias, as does the male amentum; the female amentum and fruit are both at present unknown, but we trust ere long they will be detected and published."

Bowenia is a unique example of a cycad, possessed of leaves which are more than once divided—the normal character is the pinnately divided frond, as shown in Fig 2. The plant whose leaf we have selected as an example is one possessed of peculiar interest, as we have before mentioned, on account of its great resemblance to the fern family in its venation. Its stem is short and globular, and, unlike most of the family, it is not marked with the scars of fallen leaves. When first introduced into this country, now about twelve or fourteen years ago, the plants from their novelty realized large sums of money—several stems selling for £5 or more a-piece.

One of the finest collections of living specimens of this family in Europe, if not, indeed, the richest, is that at our National Botanic Garden at Kew. A very large number of species may there be seen growing in all their native luxuriance in the magnificent Palm House. Fig. 1 will give an idea of one of these, which must be of enormous age; it is probably one of the oldest plants in the garden, and must have passed through many vicissitudes in its native land ere it was transported to our country. The lower parts of the stem are partially charred upon the outside, which looks as though it had suffered in one or more of the bush fires so common in that country. But it has survived all its trials, and is now in robust health, and will probably be so, we might almost say, for centuries to come. The garden of James Yates, Esq., of Lauderdale House, Highgate, also contains a magnificent collection of cycads, including many rare species. In the Botanic Garden

of Hamburgh, and one or two other continental gardens, there are likewise good collections.

There is a great and general partiality on the Continent for the commoner kinds of cycads which are grown for decorative purposes. In many of the small nursery gardens round Dresden, *Cycas revoluta* was, a few years ago, extensively cultivated; whole hothouses were devoted to numerous specimens of this one plant, and it would appear to be a profitable business the growing of these plants, for it is a very general practice for the mourners at a funeral to carry fronds of this plant in their hands when following a departed friend to the grave. The custom originated, it is said, among the Jews, but is not now confined to them. They are well adapted to the purpose, being somewhat rigid and yet gracefully curved, and as the pinnæ are numerous, narrow, and thickly crowded together, they have somewhat the appearance of green feathers on a large scale. The resemblance of the fronds of cycads to those of palms has led to their being substituted for them in many Roman Catholic countries where palm branches cannot be obtained, and they are often carried in processions on Palm Sunday. In New South Wales the fronds of Macrozamia are generally used for this purpose.

Cycads have their economic uses, too, and are therefore looked upon as valuable plants in some of their native countries. Thus we find that from the nuts of *Cycas circinalis*, L., which is very abundant in many of the East Indian forests, especially in Malabar and Cochin, a kind of sago is prepared. For this purpose the nuts or seeds are exposed to the heat of the sun for a few weeks to dry, the kernels are then taken out and pounded in a mortar. This flour is extensively used by the forest tribes and poorer classes of the natives in various parts of India and Ceylon. This plant grows also in the Fiji Islands, but not very plentifully; a kind of sago is there prepared from the pith of the stem, but on account of the comparative scarceness of the plant it is not an article of general use, and is used only by the chiefs and their guests. From this species a clear transparent gum-resin exudes, which hardens by exposure to the sun and much resembles gum tragacanth in appearance. This gum in India has the repute of being a good antidote for snake bites, and is also used for ulcers of all descriptions.

The genus Macrozamia has a wide distribution in Australia. The nuts of *Macrozamia spiralis* form an article of food in times of scarcity; they have, however, little to recommend them, and unless properly prepared are apt to produce unpleasant effects upon the system. This can be obviated by first steeping the nuts in water and then roasting them. A quantity of gum, resembling tragacanth both in substance and appearance, is

exuded by the cylindrical half-buried stem of this plant. Gum is also exuded by the fruit, but it is darker and more transparent than that obtained from the stem.

In the Bahamas, the natives prepare a kind of starch from the trunk of *Zamia tenuis*, Willd., which they use as arrowroot, and for which, being very pure, it is a good substitute. In many of the West Indian Islands another species of the same genus, *Z. furfuracea*, Ait., furnishes a similar article of food. *Dion edule*, L., is a native of Mexico, and an abundant supply of starch is there obtained from its seeds, and forms by no means an unimportant article of food. The nuts of this plant are much larger than those either of Cycas or Zamia, and approach nearer to those of the Australian genus, Macrozamia, the ordinary size of them being about that of a common chesnut, though occasionally seen much larger.

It will be seen that starch, or sago, is produced by most of the plants belonging to this order, and may be prepared either from the trunk or the seeds. This, naturally enough, led to the belief, some years ago, when the true source whence our commercial sago was obtained was yet unknown, that it was furnished by these plants. They were then looked upon as palms, and the East Indian species acknowledged without doubt as furnishing the source whence our supplies were obtained; more recent researches, however, prove that the sago so largely imported into this country is obtained from a true palm.

We have thus attempted to describe the peculiarities, value, and uses of one of the most singular natural orders in the whole vegetable kingdom. Their interest is not confined to one point, but is manifold, whether as to their singular habits, their geological history, or their present economic uses. The cycads therefore deserve a greater claim upon our attention than has been hitherto given to them.

DISCOVERY OF POISON ORGANS IN FISHES.

COMMUNICATED BY HENRY WOODWARD, F.Z.S.

All comparative anatomists, from Cuvier down to the present day, have decided to treat the accounts given by Pliny, Ælian, and Oppian, and other old writers, of the poisonous nature of wounds inflicted by fish-spines as incredible, and only deserving a place among "Old wives' fables." Cuvier observes, "having no canal, nor communicating with any gland, they are unable to shed any venom, properly so called, into the wound."

Notwithstanding the verdict of science against the common belief of fishermen, not only on our own coasts, but on the shores of France and Spain, and among the natives of India also, the conviction has always prevailed, that certain fishes (belonging to the family of *Acanthopterygii* or perches), armed with strong spines upon the gill covers and the dorsal fin, inflicted poisonous wounds with these defences.

That this is really so would seem to have been proved by numerous cases recorded upon good medical authority, of severe inflammation and permanently stiffened joints, resulting from punctures inflicted by the spines of the "common weever," or "sting-fish" (*Trachinus vipera*), of our shores.

The virulence of such injuries, has, however, always been referred, in books upon natural history, to the rugged and lacerated condition of the wound, or to the serrated form of the spine which caused it. This may be true in the case of wounds caused by the cat-fish and other Siluroid fishes armed with serrated spines; but certainly does not account for the virulence of wounds produced by smooth-spined fishes like the perch family.

Professor Allman made a most interesting communication upon this very subject, so long ago as November, 1840, to the *Annals and Magazine of Natural History* (vol. vi., p. 161). He there says, "On the 9th August, 1839, I was wounded near the top of the thumb by a *Trachinus vipera*, which had just been taken in a seine with herrings, sand-eels, etc. The wound was inflicted by the spine attached to the gill-cover, during my attempt to seize the fish. A peculiar stinging pain occurred a few seconds after the wound, and this gradually increased during a period of fifteen minutes. The pain had now become most intolerable, extending along the back of the thumb towards the wrist; it was of a burning character, resembling the pain produced by the sting of a wasp, but much more intense.

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The thumb now began to swell, and exhibited an inflammatory blush, extending upwards to the wrist.

The pain was now distinctly throbbing and very excruciating. In this state it continued for about an hour, when the pain began somewhat to subside, the swelling and redness still continuing. In about an hour and a half the pain was nearly gone. Next morning the swelling of the thumb had but slightly diminished, and was in some degree diffused over the back of the hand, the thumb continued red and hot, and painful on pressure over the metacarpal bone. In a few days the swelling had completely subsided; but the pain on pressure continued for more than a week."

The spines of the opercula in this fish, of which we have two species (the *Trachinus vipera* and the *Trachinus draco*), are deeply grooved along their edges, each groove terminating at the base of the spine in a conical cavity. The integument is continued over the spine to within a very short distance of the point, forming a complete sheath for nearly its entire length, and converting the grooves at each side into perfect tubes, extending from the base to the point of the spine. The result of this arrangement is a structure beautifully adapted for the conveyance of a fluid from the base to the apex of the spine.

The spines of the dorsal fin in the Weevers are also grooved, but the grooves become superficial, and disappear towards the base, and do not terminate in cavities similar to those at the bases of the spines of the opercula. Professer Allman did not succeed in detecting any specific gland connected with this apparatus, but at the bottom of each of the conical cavities of the opercula he noticed a small pulpy mass, which he considered might possibly be a glandular structure; but he adds, "In ascribing to it the property of secreting the virus, I do nothing more than hazard a conjecture."

The next recorded observations upon this subject are by Isaac Byerley, Esq., in the *Proceedings* of the Liverpool Literary and Philosophical Society, vol. i. p. 156, May, 1849.

Mr. Byerley records carefully the effects produced by wounds from these fishes, and gives also sections of the spines, to show the side grooves which Dr. Allman had already described. He says it has been suggested that the fish is capable of secreting mucus from its skin of great acridity, which, following the spine into the wound, might produce the effects mentioned. A large quantity of mucus is secreted by means of glands under the skin in all fishes, but it would, Mr. Byerley considers, be very remarkable that the *Trachinus* alone should secrete it of so irritating a quality. The upper part of the membrane covering the spines, especially the opercular ones,

forms such loose envelopes to them, that it is quite possible a portion of such secretion might intervene between the spine and its sheath, and, in that case, the spine would always have a charge of virus ready for use.

I always (he adds) favoured the idea that acrid mucus, either normally so formed, or the result of excitement, was the cause of the phenomena we have been considering until recently, but having observed a new structure occupying the grooves in the spines, which appears to be an organ destined to secrete a specific poison, I have willingly given up the doubtful for what appears to be a certain cause.

And it was just this one mistake which *prevented* Mr. Byerley and his friend Dr. Inman from arriving at probably the true solution of this interesting anatomical point.

Dr. Inman (Mr. Byerly tells us) was fortunate enough, not having an immediate opportunity of examining the fishes in their fresh state, to immerse them in spirit and water, in consequence of which the gland became more opaque and denser.

I (he adds) always had fresh fishes at hand, and in preparing the parts for examination without having used spirit, must have torn the gland from its usual resting-place. *In fact* what Mr. Byerley saw *only in spirit-specimens*, was, in reality, no organ at all, but the *coagulated* mucus fluid occupying the opercular grooves and the space within the integument of the spine, which only became visible from the effect of the spirit upon the secretion. The structure which he figures and describes as glandular, is merely the thickened appearance of this fluid under the microscope.

It remained for my distinguished friend and colleague Dr. Albert Günther, to give a complete demonstration of this most interesting point of Ichthyological anatomy. He did so in describing a new species of Batrachoid fish, from Panama, before the Zoological Society, on 22nd March last.

Dr. Günther remarked that many fishes were dreaded on account of their spine defences, such as the Sting-rays and Siluroid fishes, and some scaly fishes, as the Weevers. Exaggerated accounts, no doubt, were often circulated of the venomous nature of these fishes; still, in some cases, it seems certain the wounds must have been poisoned. No trace, however, of an organ secreting a poisonous substance could be found, and all handbooks of comparative anatomy denied the presence of such a gland in any fish.

The axil of the pectoral fin of many Siluroid fishes, Dr. Günther observed, contained a cavity with a mucous fluid, which might be introduced into a wound by means of the pectoral spine like the poisoned arrow of the Bushman. He had no doubt of the poisonous nature of the contents of

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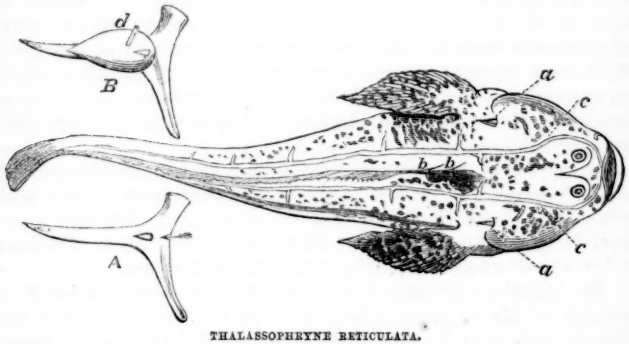
this axillary sac after discovering in another genus of fishes a poison-organ which structurally is identical with and as complete as that of the venomous snakes. This fish belongs to the family *Batrachidæ*, and a single species of the genus has already been described in the Museum catalogue of fishes, part iii. page 174, under the name *Thalassophryne maculata*. Being a very small species, Dr. Günther did not discover the apertures in the spines, although really existing. A second species having been recently brought over with a collection of fishes from Guatemala by Messrs. Salvin and Godman, which has been named *Thalassophryne reticulata*, being ten and a-half inches long, the structure of these spines was more easily discovered.

This fish is armed with a single sharp spine upon each opercular bone, and two upon the dorsal fin eight lines in length. Each spine has an aperture on its anterior surface just below the apex, and upon pressing back the integument in which it is enveloped nearly to its summit, a thick creamy fluid flowed or spirted from the aperture. Upon removing the integument with a dissecting knife a small sac or reservoir was exposed, attached to the opercular



THALASSOPHRYNE RETICULATA.

a a, The opercular spines. *b b*, The dorsal spines. *B d*, Opening in poison sac. *c c*, The mucous canals.

bone near its base, which contained the same creamy fluid which had previously been seen to exude from the aperture near its apex. On inserting a bristle into this aperture it reappeared at another opening near the base of the spine, and within the sac or reservoir already described. A tube leading from this reservoir was also detected, having a free end lying within the sac, and evidently being the canal by which the fluid was conveyed to this receptacle. There seems no doubt that this canal goes directly into a branch of the mucous system of

the fish, and that it is by the mucous glands that the fluid is secreted.* The dorsal spines were found to be furnished with precisely similar contrivances.

Nobody, says Dr. Günther, will imagine for a moment that this complicated apparatus can be intended for a harmless purpose, or to emit an innocuous fluid into a wound.

This example of a special poison-organ in fishes, although an isolated one, is, nevertheless, of the highest importance, as the muciferous system supplying these glands is common to the whole class of fishes, and though not quite clearly demonstrated by a good anatomical examination, yet there are doubtless many others which will have to be added to the number; and just as in the class of Ophidia, we have some snakes with poisonous saliva and some quite innocuous, so we shall also find it to be with the mucous secretion of fishes.

It must also be borne in mind that these fish-spines are merely weapons of defence; all the Batrachoids with obtuse teeth upon the palate and lower jaw, feeding upon mollusca and crustacea.

EXPLANATION OF FIGURE OF THALASSOPHRYNE RETICULATA FROM THE PACIFIC COAST OF PANAMA, 1-4TH NATURAL SIZE.—*a a*, The opercular spines seen projecting from the sides of the fish, just above the gill openings. *b b*, The dorsal spines. *c c*, The mucous canals, which traverse the entire length of the fish on each side. *A*. The opercular spine seen separately (natural size). The openings to and from the canal by which the poison is introduced into wounds are indicated by arrows. *B*. The same spine with the poison-sac or reservoir attached, showing (*d*) the small orifice by which the poison is conveyed to the sac from the muciferous system, with its free end lying within the sac.

* The two specimens of *Thalassophryne*, being distinct species, and at present the only existing types, have not been injected or dissected further to demonstrate this point, but more specimens from Panama are shortly expected, and when these arrive, injections of the glands will be properly made.

MOSSES TO BE FOUND IN MAY.—CORD-MOSSES AND APPLE-MOSSES.

BY M. G. CAMPBELL.

THE common cord-moss (*Funaria hygrometrica*), which crowns our walls and banks almost everywhere, feels the genial power of May, and hastens to ripen and pour out the little seeds that have been hitherto so snugly encased in its pear-shaped capsule, and whose mouth, obliquely placed, and turning towards the earth, seems conveniently ready for their exit as soon as the little trencher-like lid has fallen off, and the large dehiscing annulus has unrolled, which latter act takes place immediately on the fall of the lid.

It is true that every month in the year weaves its own moss-wreath, brings its own favourites to perfection, and that, therefore, many a change, many an operation of marvel and of beauty, is continually going on around us, and as continually lost to the casual observer. But we invite our readers to a microscopic examination of the genus *Funaria*, and especially *Funaria hygrometrica*, which is so easily procurable, as excellent examples of the structure and arrangement of the inflorescence and fructification of mosses in general. The *Funariæ* are named from *funis*, a rope, cable, or cord, in allusion to the twisting of the seta in this genus, giving the appearance of a twisted cord.

They are acrocarpous, sub-biennial and loosely cæspitose mosses, with a stem at first simple, and crowned by a barren discoid flower; subsequently they become branched, and terminate in fertile flowers, each producing a solitary capsule, obliquely pyriform, sub-ventricose, and of thick texture, with a mouth always more or less oblique, and often small, surrounded by a double peristome of sixteen divisions each; the outer consisting of sixteen oblique, lanceolate-tapering teeth, having numerous prominent trabeculæ on the inner side, and all connected at their apices by a small, reticulated, and circular disc. These teeth are also longitudinally marked with fine striæ, and have the property of being remarkably hygrometric, spreading outwards in drying after the rupture of the connecting membrane.

The inner peristome is, at its base, somewhat coherent to the outer. It is also divided into sixteen processes, placed opposite to the outer teeth, of a lanceolate form, and each marked with a medial or vertical line. The lid is conical or obtusely convex; the annulus, when present, large, and unrolling spirally, but in some species it is entirely absent. The leaves are of thin texture, consisting of large succulent, oblong-

hexagonal cells, or cellules, and even the nerve itself is loosely cellular, and it ceases at or near the apex.

In *Funaria hygrometrica*, or the common cord-moss, the perichætial leaves are connivent, ovate-lanceolate in form, concave, entire, nerved to the apex, and clustered together so as to form a sort of bud; the lower leaves are smaller, scattered, and more or less spreading, while those of the perigonium, or barren-flower, are denticulated both at the apex and at the base; they are of a sub-spathulate form, and have the basal margin recurved. The capsule is pyriform-incurved, strongly furrowed when dry, and having a very oblique mouth, which is surrounded by a beautifully corrugated border, not observable in any other species, and varying from deep yellow to orange or reddish as it ripens. The lid is plano-convex, with a red tumid or slightly frilled border, distinctly grooved for the lodgment of the large dehiscent annulus which unrolls spirally immediately after the lid falls away; thus, almost simultaneously, are removed two barriers to the exit of the spores, which are small, and of a reddish-brown colour. The seta, or fruit-stalk, is arcuate and flexuose, the upper part twisting to the right when dry, the lower in an opposite direction. In length it varies very considerably, from half an inch on the tops of exposed walls, to two and even three inches in more warm and sheltered situations. We have grown it under a glass, and found the seta attain to rather more than three inches in length. The outer peristome is reddish, the inner yellow.

There are three varieties of this moss. The variety *patula* has a more slender stem, branched, with spreading and somewhat undulated terminal leaves, which become twisted when dry. Variety *calvescens*, with the same kind of stem and leaves, but with a straight elongated fruit-stalk, and a more slender sub-erect capsule. We have seen some specimens brought from Switzerland which had grown to a very large size.

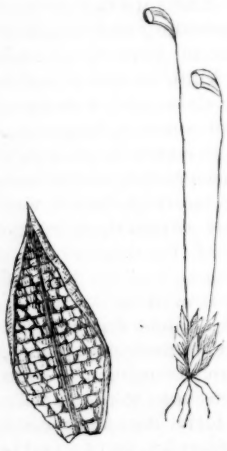
If, as we have already said, *Funaria hygrometrica*, so easily procurable, and so easily recognizable, be carefully examined for some months prior to the ripening of its capsules, it will give no very imperfect idea of the economy of this department of the vegetable world.

Previous to the appearance of the young seta at the tops of the infant shoots or stems will be seen small stellate flowers of a reddish hue. These are the barren flowers, answering to the stamens of what are called phænogamous, or flowering plants, and on dissection in water they will be seen to consist of a little cluster of vesicles of an oblong bladder-like form, mingled with jointed pellucid filaments, the first named *antheridia*, the second *paraphyses*, and these are surrounded by several rows of spreading leaves constituting the *perigonium*. The *antheridia* are

at first filled with a semi-gelatinous loosely cellular tissue, each cellule containing a spermatozoid, which consists of a spiral fibre, having attached to it a very small oval or roundish corpuscle, which is usually found near the middle of the spire. On the escape of the contents of these antheridia when mature, more or less of an explosive action takes place, and very soon after being launched into the water the spermatozoids begin to fidget, then to gyrate rapidly within the cells, and eventually bursting the walls of their cellules, they escape from confinement, and may be seen for several hours moving about in various directions in the water, as if wild with new-born joy at their escape from imprisonment.

Thus far we have treated of the barren flower only, but the genus being monoicous, the fertile flower may easily be found by dissection at the apex of a young shoot at precisely the same season, and on the same individual plant. This flower is composed of slender flask-shaped bodies, called *archegonia*, which are mixed with jointed filaments named *paraphyses*, and both surrounded by a little cluster of leaves, which stand erect, and which at length become the *perichætium*.

In length the *archegonia* somewhat exceed the *antheridia*, but they are much more slender, indeed filiform, except towards the base, where they appear slightly tumid, and at the apex, which is somewhat expanded, the filiform connection between the apex and the base being a canal in which is lodged a roundish vesicle, the nucleus or germ of the future capsule and its fruit-stalk; and the perfect archegonium soon becomes enlarged and swells out by the increase in bulk of the vesicle within it, which at length rends it asunder by a horizontal fissure near its base. The upper part is then converted into the *calyptra*, and the lower becomes the *vaginula*, while the rudimentary vesicle itself is metamorphosed into a fruit-stalk, its tapering base inserted firmly into the vaginula, and having its apex sheathed by the embryo calyptra. This stalk or seta goes on increasing in length until it has attained its full height, until which time the apex remains, as it were, stationary, but then it swells out, and developes into the capsule. This capsule consists of a central pillar, or column, called the *columella*, surrounded by a membranous pouch or bag, called the *sporular sac* or membrane, within which the spores, analogous to the particles of



pollen in flowering plants, are safely lodged in rings of mother cells, till the period when they are ready to take an independent position in the field of nature. The layer of sporules being surrounded by the sporal membrane, which consists also of two rings of cells, the outer one containing green granules, the inner pellucid; and these are again surrounded by the thecal membrane, consisting also of two rings of cells, the inner tinged with green granules, the outer pellucid; the size of the space between these two membranes differing not only in different species of mosses, but also in the same species at different periods of growth, being in contact in some, as in *Orthotrichum diaphanum*, and in others, "of which *F. hygrometrica* and *Bartramia pomiformis* are," says Mr. Valentine, "the most marked examples; they are widely distant, this distance, however, constantly diminishing by the growth of the columella and the gradual development of the sporules;"* and over all is the *theca* or outer wall, whose cellules are slightly tinged with brown.

At this early stage the mouth of the capsule is closed up by the lid or *operculum*, and an intermediate coloured ring, the *annulus*, formed of large cellular tissue, which, affected by surrounding moisture, causes the lid to fall off, and disclose the beautiful peristome, whose hygrometric action regulates the escape of the ripened spores. The outer row of teeth in this double peristome is a fringy continuation of the *thecal* membrane; the inner, a like continuation of the *sporal* membrane.

Arrived at this stage of maturity, the short branch which bore the fertile flower has become much elongated, overtopping and concealing the barren flower, which will now appear to be at the base of the stem; and amid the cells of the theca, towards the base of the ripe capsule, may be discovered, by a good glass, those little stomata or pores, considered by Mr. Valentine as the necessary apparatus for the admission of air, in order to give greater firmness to the coats of the spores, and the better prepare them for germination. In the young state these stomatas are very small, and much less numerous than when the theca has arrived at maturity; and in *Funaria hygrometrica* we have one of the two exceptions mentioned by Mr. Valentine in the *Transactions of the Linnean Society*, vol. xviii. page 240, in the form of the stomata of mosses, as observed by him. He says:—"Of 103 British species of mosses which I have examined, 78 are furnished with stomata, their usual shape similar to the most common form in phænogamous plants," to which he adduces only two exceptions, *Funaria hygrometrica* being one, each of whose stomata consisting of a single cell in the form of a hollow ring, with the sides "so compressed as to convert the aperture into a mere slit."

* *Linnean Trans.*, vol. xviii. page 241.

We are not aware whether Mr. Valentine has fulfilled his hopes of turning these stomata of mosses to account in the arrangement of genera; and for ourselves we incline to prefer more obvious characteristics as the foundation of generic distinctions; because, though every trace of nature's workings must be teeming with interest and pleasure to the initiated, we would lay on no additional bolts and bars to impede the entrance of the uninitiated into this temple of wonders.

But we have dwelt long enough on *Funaria hygrometrica;* before, however, turning to the other two members of this genus which we will briefly describe, we would just remark that *F. hygrometrica* has received from the French the name of *La Charbonnière,* from its frequent occurrence on those parts of woods, heaths, and moors which have been charred by fire, or where anything has been burnt; it ought therefore to be a constant follower in the wake of the gipsy's camp.

In the two remaining Funarias the fruit-stalk is straight, *i.e.,* not arcuate, and the capsules destitute of an annulus.

In *Funaria Hibernica,* or the *Irish cord-moss,* the fruit-stalk throughout its length twists to the left when dry, and the capsule is shortly pyriform, with a convex and papillate lid; the leaves are ovate-oblong, spreading, sharply serrated, and gradually tapering to an acuminated point. It was originally found by Mr. J. Drummond on a chalky soil, near Cork, and has since been met with by Mr. Wilson, as mentioned by him in his *Bryologia Britannica,* on a limestone soil, near Matlock in Derbyshire, and also near Conway, North Wales. But, as he remarks, it is often confounded with *Funaria Mühlenbergii,* which strongly resembles it, but is somewhat less of stature, and which grows in similar situations, namely on calcareous banks, walls, etc., forming lax patches, with stems from one to three lines only in length, very simple, leafless in the lower part, and rooting only at the base. The lower leaves are somewhat spreading or reflexed, the upper ones more erect, larger than the lower, concave, widely ovate, and suddenly acuminated, not gradually as in *F. Hibernica,* and instead of being acutely serrated, the serratures are blunt; the capsule is still more shortly pyriform, smooth, sub-erect, somewhat constricted below the mouth when dry, and of a yellowish or reddish-brown colour. The fruit-stalk is about half an inch in length, and, as in *F. hygrometrica,* the upper part twists to the right when dry, and the lower part in the opposite direction; the lid too is furnished with a reddish border, and the outer peristome is of a bright red tint. The calyptra is yellowish, the spores are granular on the surface, and twice as large as those of *F. hygrometrica.*

All three are found in fruit in May, and *F. Mühlenbergii*

takes its name from Dr. Mühlenberg, its first discoverer, who met with it in Pennsylvania. There are three varieties of this moss, having slight differences in the leaves.

Of the Bartramieæ, or apple-mosses, *Bartramia pomiformis*, or the common apple-moss, already alluded to, and *Bartramia Oederi*, Oeder's apple-moss, both fruit in this month.

The generic appellation of this genus was given in honour of Mr. Bartram, an American traveller and botanist; and its English name is descriptive of its sub-spherical capsule, which greatly resembles a miniature apple, fresh when moist, and when dry, furrowed, like a withered winter fruit.

The apple-mosses grow upon rocks or upon the ground, in perennial turfy patches, bearing terminal fructification. Sometimes, but rarely, they are found on the bark of trees. They differ in their inflorescence, which may be synoicous, monoicous, or dioicous, and in their peristome, which is sometimes single, sometimes double, and sometimes entirely wanting; but the form of the capsule is so marked, that they can hardly be mistaken for any other. The rapture which we felt, now many years ago, on first meeting with some specimens of this exquisite genus will, we are sure, be a life-long joy.

B. pomiformis, or the *common apple-moss*, may be found on dry shady banks in a sandy soil, and one variety, with longer and crisped leaves and long slender branches, inhabits the fissures of sub-alpine rocks.

With densely tufted stems of a glaucous green, dichotomously branched, and varying in length from half an inch to two inches, *Bartramia pomiformis* has crowded leaves, more or less spreading, linear-lanceolate, narrow and tapering, the border tumid, with a double row of spinulose serratures; the nerve sub-excurrent, and in the dry state the leaves are somewhat crisped or tortuous. The barren and fertile flowers are contiguous; the fruit-stalk from half an inch to an inch long, bearing the sub-globular cernuous or inclined capsule, of a reddish-brown colour, and, as in all the genus, furrowed when dry; the lid is small and sub-conical; the peristome double, the inner shorter than the outer teeth, and sometimes having cilia, sometimes without.

Bartramia Oederi, Oeder's apple-moss, is also found on shady rocks, but chiefly on such as are calcareous and in a moist situation. It grows in soft, lax, extensive patches, of a dark green colour; its slender stems being beset with radicles, and reaching a length of from one to three inches; its leaves recurved, and spreading every way, shorter than in other British species, and not sheathing nor suddenly dilated at the base, lanceolote and sharply keeled, the margin recurved and serrated at the apex, and the nerve sub-excurrent. In the dry state the leaves are crisped.

The capsule is small and oblique, with a rather large mouth in proportion to the size of the fruit, the lid plano-convex, and the fruit-stalk short, scarcely half an inch in length.

Both these fruit in May.

Bartramia ithyphylla,* or the *straight-leaved apple-moss*, grows on alpine and sub-alpine rocks, is common on the rocks above Greenock and on various mountains, both in Scotland and Wales; it has also been found near Todmorden, in Lancashire.

With rigid leaves of a bright yellowish green, subulato-setaceous, more or less spreading from a pale sheathing dilated base, "by which character, and the broad predominant nerve," Wilson says, "this species is easily distinguished from every other British species." The fruit-stalk is about an inch in length, and the leaves are straight when dry; hence its distinctive appellation.

Bartramia rigida, or the *rigid apple-moss*, is a dwarfish species, with very short slender and fragile stems, from two lines to half an inch in height, downy, of a red colour, and having dark reddish radicles. From the branches being fasciculate, and slightly recurved with crowded leaves, it grows in compact tufts. It is found on shady banks in mountainous situations in Ireland. The leaves are lanceolate, tapering upwards to a narrow point, erecto-patent, straight, and rather rigid, the margin reflexed and serrated, rough on the back, with small roundish prominences or glands, which also cover the strong excurrent nerve. The areolæ of the leaf have an oblong-quadrate form. The fruit-stalk is about three-quarters of an inch in length, of reddish hue, and bearing the comparatively large sub-spherical capsule, which is at first oblique, but subsequently cernuous, of a reddish brown, and strongly furrowed when dry. A double peristome surrounds the mouth, the outer teeth of a reddish brown, and rather short, the inner still shorter and sometimes deficient or rudimentary. The lid is convex and apiculate; the spores are reddish, partaking of the general hue of the plant, and the inflorescence is monoicous; the barren and fertile flowers approximating; and the fruit ripens in September and October.

Bartramia fontana, or the *fountain apple-moss*, grows in wet places, especially near springs, as the name implies, and is found chiefly in mountainous countries. It has elongated stems, from one to six inches long, or even more, downy, with blackish or reddish radicles, and matted together in dense, extensive, yellowish or glaucous-green patches, the branches variously ramified, slender or robust, sometimes fasciculate and erect, sometimes disposed in a stellate manner; the leaves dimorphous, either ovate-acuminate, short and appressed to

* From ἰθύς, placed upright, erect, or straight, and φυλλὰς, foliage.

the stem, or longer, and lanceolate, spreading, or secund, obscurely plicate at the base, bluntly toothed or serrated, and having the margin recurved below, with a sub-excurrent nerve, which sometimes ceases below the apex. The leaves are also papillose at the back, and those of the principal stem are broader than those on the branches. The capsule is of thick texture, and large size, of a reddish-brown colour, curved, and longitudinally furrowed when dry; the teeth of the outer peristome are closely barred, and the inner furnished with cilia, bundled two or three together. The fruit-stalk is long and of considerable tenacity. The spores are rather large and reddish; the inflorescence dioicous, the inner leaves of the perigonium obtuse and horizontally spreading from a broad concave base, the nerve so very faint as to be visible only with difficulty and always ceasing below the apex.

There are several varieties: variety *alpina* has short robust stems, with densely leafy branches, of an ovate-lanceolate form, mucronate, and having shorter fruit-stalks. Variety *falcata* has yellowish falcato-secund leaves, with a thick reddish nerve, and having the branches curved at the apex. Variety *pumila* has very slender short stems, with small narrow leaves, and a small capsule.

The inflorescence is dioicous and it fruits in June.

Bartramia calcaria, the *thick-nerved apple-moss*, has also a dioicous inflorescence, and grows, too, in wet places, but seems confined to limestone districts, and has longer and more rigid leaves than *B. fontana;* they are also less papillose, have a stronger nerve, larger areolæ, and the margin is not recurved: the perigonial leaves also differ considerably, being tapering to a very acute point, and nerved to the apex, while the teeth of the peristome, instead of being closely, are but remotely, barred. It has been found in the Highlands of Scotland, near Todmorden, in Lancashire, and at Hale Moss, in Cheshire. Its fruiting season is July, and it grows in dense patches of a more intense green colour than *B. fontana*.

In *Bartramia Halleriana, Haller's apple-moss*, the inflorescence is monoicous, the stems are somewhat elongated, from one to three inches in height, with irregular, but fastigiate branches, *i.e.*, the branches, wherever they begin, all reach an equal height. It forms soft, lax tufts, of a bright yellowish green colour, but as the stem descends it becomes covered with radicles of a rich brown tint. The long slender leaves are linear-subulate, and seem to spread in every direction from an erect dilated, slightly sheathing base, which is pale, and somewhat shining—sometimes however they are sub-secund; they are roughish on both sides, serrulate at the margin, and are tortuous or crisped when dry. The fruit-stalk is very short,

not as long as the leaves, only about two lines in length, curved, and seeming to be lateral, in consequence of the growth of innovations, which are usually solitary; but the flowers, when examined at an early stage, are always found to be truly terminal. The moss is an inhabitant of alpine and sub-alpine rocks, and fruits in June and July, sometimes bearing two or three capsules together.

Bartramia arcuata, or the *curve-stalked apple-moss*, strikes us, at first sight, as an exaggeration of *B. Halleriana*, with red fruit-stalks, which, though longer, are still short and arcuate, being only about twice or thrice the length of the capsule, which hangs sub-pendulous upon it, and, as in *Halleriana*, have the appearance of being lateral from the same cause, namely, the growth of innovations. It, too, grows in extensive yellowish-green patches, but the stems reach from two to four inches in height, densely covered with reddish-brown radicles, and the leaves, which are plicated, are of an ovate-lanceolate form, shining, sheathing and erect at the base, thence widely spreading, with a nearly plain serrulate margin, and an excurrent or sub-excurrent nerve. It grows on moist heaths and on the rocky banks of streams in hilly places, forming dense masses; and though its rich golden globular capsules are rarely met with, its bright yellow-green foliage contrasts agreeably with the downy fuscous radicles that so thickly clothe the lower part of the stem, and this contrast renders it a most attractive object even in the barren state. Its fruiting season is September and October, two or three months later than *B. Halleriana*, and it may be met with on the Sidlaw Hills, above the village of Auchterhouse, in fruit; it is also said to be abundant at Lodore Waterfall, near Keswick, and in fructification at Lidford Fall in Devonshire, and at Cromaglonn, near Killarney, Ireland; also sparingly in fruit near Llyn Ogwen in Carnarvonshire.

Another species, *Bartramia cæspitosa*, hitherto considered Swedish, has lately been found by Mr. Wilson, in a new marsh near Warrington; but not having seen a specimen, we are unable to describe it.

Bartramidula Wilsonii, or the *beardless dwarf apple-moss*, is a most beautiful little plant, somewhat resembling *Bartramia fontana* in miniature, but its exquisite little pink capsules are sub-pendulous or quite pendulous, and hang on reddish arcuate fruit-stalks, often three or four together, and resembling full short pears rather than apples in outline, are smooth, shining when dry, with thin, somewhat pellucid walls, which are of soft texture, slightly rugose in the dry state, but not striated, and having a small mouth destitute of peristome, and closed with a small sub-conical lid, which is again surmounted by a small,

cuculate, but very fugacious calyptra. The vaginula is oblong, and the spores are reddish, granular on the surface, and, notwithstanding the diminutive stature of the moss, its stems scarcely reaching half an inch in height, they are even somewhat larger than the spores of *Bartramia fontana*. The branches are fascicled, two, three, or more together, and sub-erect; the leaves ovate-acuminate, or lanceolate-acuminate, slightly secund and sub-erect, the nerve reaching nearly to the apex, or sometimes excurrent; they are finely serrated in the upper part, and are composed of rather lax oblong cellules. The fruiting season is October, and it has been found growing in different localities on the mountains of Scotland, Wales, and Ireland; but Mr. Wilson says, "It has not yet been observed in any other country, and is liable to be overlooked on account of its diminutive size."

Of the two other species of apple-moss, *Catoscopium nigritum*, or the *lurid apple-moss*, is somewhat allied in habit to the *Bartramia*, but Bridel and Wilson make a separate genus for it, named *κάτω* from *down*, and, *σκοπέω* to *look*, in allusion to the appearance of the capsule, which suddenly bends forward, as if looking down from the top of its seta, or solitary elongated pedestal. It is small, roundish, smooth, shining, and of a thick texture, almost horny, with a rather oblique mouth, destitute of an annulus, and having a small conical lid, which covers a single peristome of sixteen short, lanceolate, or truncate teeth, transversely barred, irregular, and marked with a medial line, which leads one to suspect that, as in some other mosses, it may be the junction of two teeth cemented, as it were, into one; sometimes, also, obscure traces of an inner peristome may be discovered. The spores are comparatively large and smooth; the calyptra small, shaped like a little hood, smooth, and usually fugacious, though occasionally found remaining on, or rather adhering to the fruit-stalk beneath the capsule, which, when mature, is black, hence its specific name.

The inflorescence is dioicous, with terminal flowers; the leaves lanceolate, carinate, nerved, somewhat recurved, and spreading; the areolæ small, quadrate, and opaque, and though the species is rare, being found only in a few places, it is perennial in its native habitats, which are moist alpine rocks, or subalpine marshy places. It is plentiful on Ben-y-gloe, near Blair, in Athol, and we have seen specimens brought from the sands of Barrie, on the coast of Forfarshire—a circumstance which goes to prove what has been often asserted, namely, that the climate of the lofty mountain and that of the seashore are very closely allied, and the sight of this little tenant of the mountain wild, and of the lowly beach, ever brings with it associations both pleasing and sublime. It grows in soft green tufts, the

stems varying in height from two to six inches, or even more, slender, almost filiform, flexuose, and beset with reddish brown radicles in the lower part.

The only remaining example is the *naked apple-moss, Discelium nudum,* to which also a separate genus is given, named from δις, *twice* or two, and σκηλος, a *leg,* because the teeth are split into two divisions from the base to the middle, giving the appearance of legs. They are also jointed. *Discelium nudum* is the only known species of this singular genus, which seems to combine in itself some of the attributes of three others; for example, it resembles *Catoscopium* in its capsule, *Phascum* in its mode of growth, and *Trematodon* in its peristome. Like the Phascums, it is almost stemless, and, like them, grows from a conferva-like thallus, which in *Discelium* has a green velvety appearance; the leaves are few and imbricated, concave, entire, ovate-lanceolate, and almost destitute of nerve; the areolæ lax, oblong-hexagonal, and diaphanous. Their number is about six or eight, and they seem to be solely or chiefly a gemmiform envelope for the inflorescence. When old they are of a pale reddish hue, and the green velvety thallus withers and becomes discoloured soon after the formation of the fruit; and frequently by the action of the frost in winter it decays and mixes itself with the mould of the substratum, even before the ripening of the capsules, which does not occur till February or March. The capsule is sub-globose, as we have already said, resembling Catoscopium, but is reddish in colour, and more or less cernuous; the lid, however, is large, conical, and more or less acute; the annulus, too, which is sub-persistent, is large, composed of a double row of cellules; the vaginula oblong, not much thicker than the fruit-stalk, which latter is about an inch long, reddish, and flexuose; the calyptra is narrow, smooth, and subulate, and splitting on one side throughout its whole length, the fissure ascending spirally. Like that of Catoscopium, it is fugacious, or when entire at the base, which is frequently the case, being longer than the fruit, it remains attached to the fruit-stalk beneath the capsule. The spores are of moderate size, punctulate and reddish.

The favourite habitats of the species are the clayey declivities of the North of England and Scotland. It was first discovered by Mr. George Cayley near Manchester; Mr. Don also found it by the side of the river Tay near Perth; and it has since been met with in several places, especially in the neighbourhood of Manchester, turning the vicinity of that busy scene of manual labour into classic ground for the botanist and the lover of nature's most lovely forms, and linking it with associations and recollections, apart from the every-day turmoil of the struggle for existence.

MOLECULAR MOTIONS IN LIVING BODIES.

BY HENRY J. SLACK, F.G.S.,
Member of the Microscopical Society.

BEFORE suggesting inquiry into the part which molecular motions perform in the growth and decay of living organisms, I shall endeavour to make the subject more generally interesting by a few preliminary observations, which may assist those to whom it is entirely new.

In order to know what molecular movements are, a small drop of water should be placed on a glass slide, just touched with a fine camel-hair brush whose point has been dipped in gamboge, then covered with a thin glass, and viewed with a ¼ objective and second eye-piece, or with a higher power, if one is at hand. The scene disclosed to the eye is singularly striking when first observed, and may be frequently seen without losing the interest it originally inspires. Thousands of little round particles are perceived to keep up an active fidgetty motion, sometimes approaching, sometimes receding, rolling, quivering, shaking, and comporting themselves not unlike a swarm of live creatures suddenly frightened and not at all clear what they are about. If the water does not evaporate, the spectacle may be watched for hours, until, at length, it usually happens that the particles adhere to the glass, and quiet is restored.

The French call these movements "Brownian," after their discoverer, the famous English botanist, and they may be produced with any material not soluble in water, provided the size of the particles is proportioned to their own specific gravity and to that of the fluid. What is required is, that the particles shall be freely *suspended* in the liquid, and be of minute dimensions. Substances of nearly the same specific gravity as water will have little tendency to rise or fall, and that tendency is easily controlled, for a time, by reducing them to a moderate degree of fineness. The particles of the water cohere with a certain force, so that a greater force is necessary to make any substance move either upwards or downwards in that fluid. It is more easy to move through a light fluid than a dense one. Fresh water, for example, opposes less resistance than salt. Every bather has noticed the difference between trying to touch the bottom in a river and in the sea, while Dead Sea water is so heavy as to make swimming an easy task for an animal not specifically heavier than a man. In like manner limpid fluids oppose less resistance than sticky ones; and an insect that can move easily through water, is sadly impeded when immersed in glue.

When any insoluble body is pressed under water, it displaces its own bulk of that fluid. If it is lighter than that bulk, it is forced up, and floats. If heavier, it is forced down by gravitation, and sinks. But although the specific gravity of a substance is greater than that of water, it will still float, provided its surface is extended, so that the resistance of the water, arising from the cohesion of its particles, is made equal, or more than equal to, the weight of the substance, or force, with which it gravitates. Thus a film of gold leaf will float, while the same weight of gold in a pellet falls fast. From these facts it results that in order to cause a heavy metal like gold or platina to be suspended in water, with little tendency to fall, its particles must be reduced to such a degree of fineness that their *weight* is nearly counterbalanced by the resistance which the fluid offers to the passage of their *bulk*. This can be accomplished more easily than might be expected, because the weight of round bodies diminishes much faster than their size. The rule is, that the contents of spheres are as the cubes of their diameter, so that if a ball three inches in diameter weighed 27, another ball one inch in diameter would only weigh 1. Thus a moderate reduction in the size of a round particle makes a great deal of difference in its weight.

When a minute particle is freely suspended in a highly mobile fluid like water, the slightest force of any kind will disturb its equilibrium, and impart some motion; but exactly what force causes the molecular movements does not appear to have been ascertained. Dr. Carpenter gives an interesting summary of what is known, in his work on the Microscope, from which we will make a quotation. He says:—

"Nothing is better adapted to show it (the molecular motion) than a minute portion of gamboge, indigo, or carmine, rubbed up with water, for the particles of these substances that are not dissolved, but only suspended, are of sufficiently large size to be easily distinguished with a magnifying power of 250 diameters, and are seen in perpetual locomotion. Their movement is chiefly of an oscillatory kind, but they also rotate backwards and forwards upon their axis, and they gradually change their places in the field of view. It may be observed that the movement of the smallest particles is the most energetic, and that the largest are quite motionless, while those of intermediate size move but with comparative inertness. The movement is not due, as some have imagined, to evaporation of the liquid, for it continues without the least abatement of energy in a drop of aqueous fluid that is completely surrounded by oil, and is therefore cut off from all possibility of evaporation; and it has been known to continue for many years in a small quantity of fluid enclosed between two glasses in an air-

tight case. It is, however, greatly accelerated and rendered more energetic by heat; and this seems to show that it is due either directly to some calorical changes continually taking place in the fluid, or to some obscure chemical action between the solid particles and the fluid, which is indirectly promoted by heat."

The *Micrographic Dictionary* states "that neither light, electricity, magnetism, nor chemical re-agents exert any effect upon it;" but it may perhaps be worth while to verify these assertions.

After witnessing the molecular movements with gamboge, as recommended at the beginning of this paper, let two minute drops, one of water and the other of gum water, be placed near each other on a slide. Put a little gamboge into the water-drop, and then cover both drops with a light thin piece of glass. The two drops will mix slowly, and it is then easy to see the gradual effect of the introduction of the gum in arresting the motion, by diminishing the mobility of the fluid. To see the effects of heat, place the microscope upright, lay a thin strip of sheet zinc on the stage, having a little hole cut in it, and long enough that one end shall project an inch or two beyond the stop on one side; then place a piece of thin glass over the hole in the zinc, put a drop of gamboge water upon it, cover with another thin glass, place a spirit-lamp under the projecting part of the zinc plate, and watch the result as the heat is conducted to the fluid and its contents. The heat gives rise to currents in the water-drop, and the additional motion thus imparted—one of distinct translation in a given course—must not be confounded with the peculiar molecular fidget which will go on with accelerated velocity at the same time.

FIG. 1.

X 1000.

Passing from instances of molecular motion in water-drops, it is interesting to watch it in living bodies. In the cells of confervæ it may be frequently met with, and it is probably concerned in the so-called "swarming process" of desmids and other simple plants. When the chlorophyl of conferva cells is undergoing decay, the molecular movements may be continually seen; but it is not every mode of decay that breaks up the larger masses into the little particles convenient for its exhibition. Fig. 1 represents its appearance, so far as stationary dots can indicate it, in a common conferva, and I have seen it conspicuously shown in the cells of a moss often found in ponds—*Fontinalis antipyretica*.

Although frequently associated with decay, it apparently also forms part of the series of operations that take place in

healthy cells, and I think it is exhibited in many of the conditions under which the protoplasm of plants is engaged in forming new organs, as well as in other cases in which previously existing forms are being taken to pieces. In a physical point of view, all that is required is the presence of molecules of the right size, in proportion to their weight, in a fluid of suitable density, and not too viscid.

The higher the power employed, the more extensively this kind of motion can be traced. With my $\frac{1}{20}$th I have seen it well displayed in extremely minute vacuoles of ciliated infusoria, and recently was much struck with it in blood corpuscles taken from the gills of tadpoles in an early stage. I believe I am right in stating that true blood corpuscles result from embryonic or primary cells, differing considerably from perfect blood corpuscles either white or red. In my tadpole babies the particles circulating through the gills in close, chain-like array, presented, when immersed in water, instead of the characteristic reptilian form, the appearance of Fig. 2, and all the little particles represented by the engraver's dots, were in strong molecular motion, which I presume to be connected with the process of development. White nucleated corpuscles are gradually formed, giving rise, in their turn, to the red.

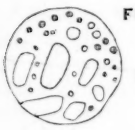


FIG. 2.

× 1000

The molecular motions must tend in living vessels, as they do in pails or jugs, to prevent a fluid from clearing by the sinking down of small suspended matters. They must also promote any chemical and physical action between the fluid and the particles which are continually rubbing themselves against it, and they may thus perform an important function in the processes both of vital construction and decay.

I append to these brief notes a few extracts from two very important papers by Professor Lionel Beale, which appeared in the January and April numbers (1864) of the *Quarterly Journal of Microscopic Science*:—

MINUTE PARTICLES OF GERMINAL MATTER IN THE BLOOD.

"In the blood of man and the higher animals a great number of minute particles, of the same general appearance and refractive power as the matter of which the white blood corpuscles are composed, may be demonstrated. Some of these particles probably, under certain conditions, grow into ordinary white corpuscles, while others, after increasing to a certain size, become red blood corpuscles.*" Dr. Beale adds that both

* *Quarterly Journal of Microscopic Science*, April, 1864, page 48.

white and red corpuscles vary much more in size than is usually supposed.

FOUR KINDS OF MATTER IN THE BLOOD.

"In the blood we have—1. Matter that is living and active. 2. Matter that has ceased to live, and which now possesses peculiar properties and chemical composition. 3. Matter which results from the disintegration of the formed material; and 4. Matter (pabulum) which is about to live, or about to be converted into living matter. . . . . I believe the colourless corpuscles, and the colourless nuclei of the red corpuscles, consist of matter in a living state, while there are reasons for concluding that the coloured material has ceased to exhibit vital properties."*

SHAPE OF BLOOD CORPUSCLES.

"If the oval corpuscles of a frog be left at rest in a fluid of about the same density as themselves, they become completely spherical, and a similar change occurs in the oval blood corpuscles of all animals that I have examined." †

THE PHOSPHATES USED IN AGRICULTURE.

BY DR. T. L. PHIPSON, F.C.S. LONDON, ETC.

It is now some twenty years since the great truth of the gradual exhaustion of soils by continued cultivation began to dawn vividly, and with all its force, upon the agricultural public of Great Britain. Numerous analyses of soils and plants, undertaken, in the first instance, to satisfy an ever-increasing curiosity, soon demonstrated, in a most forcible and practical manner, the nature of the ingredients which our crops take yearly from the soil, and which, in a country so thickly populated as England, it is indispensable to restore in some way or other to the soil, in order to keep up a proper degree of fertility.

The art of *manuring*, practised for centuries before, began to be understood within the last quarter of a century only; and though the labours of Liebig in Germany, and Boussingault in France, preceded by those of Sir Humphry Davy in this country, have contributed not a little to our present knowledge of the subject, yet in no country have the influences of science been so considerable, so gigantic, as in our own. The reason of this, doubtless, lies in the actual population of Great Britain, of which the average to the square mile is greater

* *Quarterly Journal of Microscopic Science*, January, 1864, page 34.
† *Ibid*, page 34.

than that of any other country; consequently, the soil here is caused to do its utmost, and the effects of exhaustion have been sooner and more keenly felt. Although scientific agriculture, as regards its diffusion among the people, is still in a deplorable state on the continent of Europe, as may be seen by glancing from time to time at the periodical literature of Belgium, France, Germany, and Italy, the time will certainly come when the art of manufacturing and applying manures of all descriptions will be as actively pursued in these countries as in England at the present day.

Three of the more important ingredients which soils lose by cultivation, and which it is necessary to restore to them in greater or smaller quantities, are potash, nitrogen, and phosphate of lime. Nature herself supplies these substances to the soil in various ways, and in quantity sufficient for the growth of wild plants. Thus, potash is washed into the soil by the rain-waters which flow over granitic and felspar rocks, so that every little stream contains some of it; nitrogen, in the form of ammonia, is constantly present in the atmosphere, and phosphate of lime is very widely distributed over the globe. Moreover, the excrements of animals contain all three. Another ingredient very essential to vegetable life is carbonic acid, of which there is so large a supply in the atmosphere, in the streams, and rocks of the globe, that it is rarely necessary to supply it artificially to our cultivated crops.

I have said that nature supplies a sufficiency of these more important constituents of the fertile soil, to ensure the growth and luxuriance of wild plants. But in agriculture we are dealing with an artificial state of things, and the natural supply no longer suffices to maintain fertility in our cultivated soils. In our present system of manuring potash is supplied by farm-yard manure, sometimes by wood-ashes, and by manures made by drying the excrements of animals (sewage, etc.) The first and last of these supply also ammonia and phosphates. Our chief sources of nitrogen are Peruvian guano, nitrate of soda, and sulphate of ammonia (from the gas-works). The first of these supplies, at the same time, phosphate of lime, and the last is sometimes introduced into artificial manures, such as the ammoniacal superphosphates.

Our sources of phosphate of lime are most numerous, and it is to these alone that I shall devote the present paper. A few years ago, all the phosphorus used for the manufacture of lucifer matches was extracted from bones, the phosphate of lime used in the various manufactories was likewise obtained from bones. These were principally collected in the streets and waste places, at butchers' establishments, etc. Since the manufacture of *superphosphate of lime* began for the use of the

farmer, not only immense quantities of ox bones have been imported yearly into England from South America and other countries, but a large number of natural deposits of phosphate of lime have been discovered and utilized without delay in the interests of agriculture and manufactures. It was shown by Liebig that it was of little use to supply ground bones to the soil in order to obtain a rapid result, for the bone earth takes a long time to become soluble by the action of the carbonic acid, and other vegetable acids of the soil, and cannot penetrate into the tissues of plants until it is so dissolved. In order, therefore, to furnish plants with phosphate of lime in a soluble state, Liebig proposed that bones or other phosphates should be treated with sulphuric acid. Hence arose the manufacture of superphosphate or soluble phosphate of lime, which has, of late years, taken such extension in England. It is to this manufacture principally that is owing the enormous importations of phosphate of lime in various forms which arrive in Great Britain from all parts of the globe.

It was probably the introduction of guano from South America that brought certain practical minds to consider more attentively the best means of restoring fertility of exhausted soils and of keeping up the fertility of those not yet exhausted. This extraordinary and powerful manure, the enormous supplies of which appear to have been stored up by Providence for the actual wants of agriculture, as the endless supplies of coal have accumulated in bygone ages to supply the wants of our manufactories, was brought to Europe in 1804 by Alexander von Humboldt as a *scientific curiosity*. Its valuable nature was not entirely appreciated by the public at large until about 1838, when large quantities of it began to be imported into England as a manure. Two years later (1840), Liebig brought out his well-known work on agricultural chemistry, making known the principle of the manufacture of superphosphate of lime, and in 1842, Mr. Lawes began to manufacture this superphosphate manure.

Guano being, as is well-known, the accumulated excrement of sea-fowl (and, consequently, having the same composition as the excrements of pigeons and other domestic birds), is abundant in many parts of the globe. In certain tropical regions (Peru, Chinca Isles, etc.), where it never rains, this guano is very rich in urate, oxalate, and phosphate of *ammonia*, besides containing about 22 or 23 per cent. of phosphate of lime. But in localities which are frequently visited by hurricanes and much rain, the *organic* constituents and salts of ammonia are washed out, and the *mineral* constituents increase in proportion: the guano becomes less valuable as a manure, by loss of its ammoniacal compounds, but constitutes a plentiful source of phosphate

of lime. Such are the phosphates known as "West India phosphate," "Bolivian guano," etc. These contain from 40 to 60 per cent. (and sometimes more) of ordinary phosphate of lime, whilst their per-centage of nitrogen (ammonia) dwindles down to 2, 1, or even 0·5 per cent., as the phosphate increases. Here, then, is an abundant source of phosphate of lime.

But several West India islands furnish a species of hard rock, of very peculiar aspect, consisting chiefly of phosphate of lime. Many persons consider that this rock has been derived from guano, supposing it to be the result of exposure to the atmosphere for thousands of years; others imagine it to be guano modified by volcanic action. I have examined this mineral phosphate,* and find that it contains not only phosphate of lime, but also a considerable proportion of phosphate of alumina—a substance not met with in guano: it is, in fact, a compound of phosphate of lime and phosphate of alumina, containing about 17 per cent. of the latter, and 65 per cent. of the former. As this rock is principally derived from the little island of Sombrero, I called it *Sombrerite*. This is another tolerably abundant source of phosphate of lime, much used in the manufacture of superphosphate manure.

Another hard phosphatic rock, of a similar description, is found upon Monk Island, in the Gulf of Venezuela. Although I have received for analysis in my laboratory many hundred specimens of the different phosphates mentioned in this paper, I have never yet met with this one from Monk Island; but I have reason to believe it is a substance similar in all respects to Sombrerite. Whether it be so or not cannot be determined by the few incomplete analyses that appear to have been made of it hitherto. However, it constitutes a cheap source of phosphate to manufacturers of superphosphate manure; and it appears to contain 78 to 80 per cent. of phosphate of lime.

Another, and most abundant source of phosphate of lime is, I am happy to say, an indigenous one, and one which is very extensively utilized in the manufacture of superphosphate. I allude to the Cambridge and Suffolk *coprolites*. These are hard nodules, somewhat cylindrical, and having rounded edges. The Cambridge coprolites are found in the upper green sand, where they form extensive deposits, and are so intimately mixed, on their surface, with the green sand itself, that their true colour is only seen when they are broken. They contain 60 to 65 per cent. of phosphate of lime, sometimes rather more, and when ground form a yellowish-white powder. They are supposed to be the fossil excrement of extinct animals, hence their curious name, derived from the Greek; but we have not

* *Journal of the Chemical Society*, 1862.

sufficient proof of this extraordinary supposition. However, the revelations of geology during the past twenty years have been so exceedingly wonderful, that one is readily tempted to admit that some of these coprolites are the fossil excrement of certain extinct animals, probably reptiles, and therefore correspond somewhat in their chemical composition to guano which has been deprived of its organic matter by atmospheric influences. Specimens of such guano have given me, upon analysis, from 15 to 30 per cent. of *carbonate* of lime, which resembles the proportion of carbonate of lime invariably present in every description of coprolites.

The main thing that regards the agriculturist or manure manufacturer, however, is their chemical composition, by which these Cambridge coprolites appear to be the cheapest source of phosphate of lime at present known. The Suffolk coprolites are dark brown nodules, some of which have very much the appearance of fossil bones rounded by the action of the sea. They always contain a certain amount of red oxide of iron, and about 56 per cent. of phosphate of lime; they are consequently rather less valuable than the pure Cambridge coprolites; moreover, they appear to belong to the tertiary formations.

All these coprolites, and, indeed, all natural phosphates used in agriculture, except apatite (see further), contain a certain amount of carbonate of lime and insoluble silicious matter, and it is important to manufacturers and agriculturists to have the proportions of these determined accurately, otherwise they have no control over adulteration, and no basis to work upon in the manufacture of artificial manures.

Along with Cambridge coprolites I have found fragments of fossil bone—bones of reptiles, probably—showing the same chemical composition as the rounded nodules or coprolites themselves. The Suffolk coprolites appear to be chiefly fossil bone, more or less impregnated with phosphate of iron, etc.

But the whole of the Upper Green Sand formation of England is characterized by a wide diffusion of phosphoric acid in the shape of phosphate of lime. My attention was called to this some years ago, by a relation who forwarded to me a very large specimen of fossil wood from the Green Sand of the Isle of Wight, which, upon being submitted to analysis, gave me an enormous proportion of phosphate of lime—in fact, it was chiefly formed of this substance and fluorspar—though it was not apatite;* and I learnt afterwards that Mr. Thomas Way had formerly examined several fossil polyps, sponges, etc., from the Green Sand, which gave a very large per-centage of phosphate of lime.

* See *Report of British Association*, 1861, and *Chemical News*, 1861.

This proves to us that a great amount of phosphates has been diffused through the Upper Green Sand formations, may-be by the accumulated excrement of myriads of fish and large reptiles which inhabited this country at the remote geological periods to which these formations belong.

I have since analyzed many other sedimentary rocks and fossils, in order to discover whether they contained any notable quantity of phosphate of lime, but rarely found more than one or two per cent., frequently a mere trace only. However, there exist, doubtless, other sources of phosphate yet to be discovered.

If we admit that the mineral phosphate Sombrerite and that of Monk Island be similar minerals, and have been derived, by some unknown geological process, from guano; if we admit, moreover, that the coprolites found in Cambridge and Suffolk are, like those of the Coal and Lias formations, true fossil excrements, mixed here and there with bone; and, thirdly, if we admit that the other numerous and above-named fossils (wood, sponges, polyps, etc.) fossilized by phosphate of lime, be the result of an impregnation of organic substances by the excrementitious matter of animals now extinct, what a splendid example we have here of *applied palæontology*. For since agricultural chemistry began its rapid development, all these "fossil excrements" have become valuable as a means of aiding us to keep up the fertility of our soils, to increase our wheat crops, and to have an abundant and cheap supply of bread. We are thus tempted to class all phosphates used in agriculture, including bones, bone-ash, etc., as derived from organized beings that have once flourished upon our globe.

But we have another source of phosphate of lime in the coarse variety of apatite of Estremadura, which appears to have had no connection with organized beings of any description, and cannot be considered as a fossil. The Estremadura phosphate met with in commerce is the mineral apatite in the massive form; it is abundant in Spain, and may be in other countries also, but up to the present time it does not appear to be so plentiful as the other phosphates mentioned in this paper. However, it is of all known substances found in nature that which contains the most phosphate of lime, the per-centage of which in the commercial specimens averages from 85 to 87 per cent., and in absolutely pure specimens as much as 92.

The remaining phosphates used in agriculture are bones, bone-ash, and animal charcoal. The two latter are merely burnt bone. Bones contain the peculiar phosphate known as "bone-earth," equivalent to about 56 per cent. of ordinary tribasic phosphate of lime. When ground, they often become mixed with silica and other impurities. Enormous cargoes of ox-

bone, either sun-dried or in the shape of bone-ash, are imported from South America into England.

Bone-ash is bone burnt *in contact with the air* until its organic matter is destroyed; it yields a quantity of bone phosphate equivalent to 70 or 90 per cent. of ordinary phosphate of lime, according to its degree of purity. When burnt *without contact of air*, animal charcoal is obtained; this is used to clarify sugar, juice, etc., and when spent is burnt over again. After being thus burnt twice or thrice, it becomes comparatively useless to the sugar-refiners, and is sold to manufacturers of superphosphate. According to a number of analysis made of this substance in my laboratory, it may be said to average from 70 to 80 per cent. of phosphate of lime.

Such, then, are the substances which furnish our agriculturists, our lucifer-match manufacturers, our colour-makers, etc., with their supplies of phosphate of lime. It is needless, perhaps, to add that agriculture absorbs by far the greatest portion of this phosphate, and we may be thankful that there exists so plentiful a supply of it. In a future paper I will consider our present sources of ammonia.

SNOW CRYSTALS.

BY E. J. LOWE, ESQ., F.R.A.S., ETC.

When we observe the snow beating against our windows, or being drifted into heaps by the wind, we regard it with interest, we admire its dazzling whiteness, and we are thankful to look upon its carpet, because it is a protection to tender plants from the injuries of severe frost. Few of us, however, are aware of the exquisite beauty of some of these snow crystals; very various in form, and sometimes exceedingly intricate, it becomes impossible to do justice to a snow-storm. The difficulties to be overcome are great: a lovely star descends and alights upon a leaf; paper and pencil are at hand, and the magnifying-glass reveals its beauties, but before it can be sketched in all probability it has melted and gone. If snow falls in showers, and the temperature of the air is above the freezing-point, it is almost impossible to sketch the crystals. Once or twice a year the weather is sometimes favourable for these investigations, and such a day was February 10, 1864. Let us take this day as an example:—

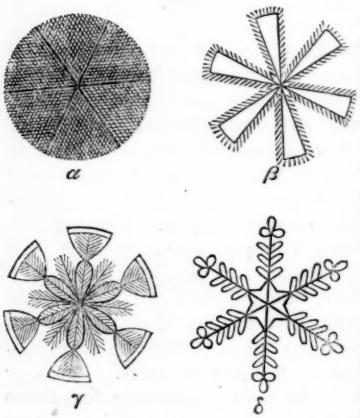
There had been a severe frost, the temperature falling to 15·8° at the height of four feet, and to 13·1° on the grass. The morning was overcast, foggy, dark, and having a peculiar yellow

smoky appearance, that is not uncommon on the advent of snow. At 9h. 15m. A.M. few snow crystals commenced falling; at 10h. 30m. A.M. the temperature at four feet was 25·8°, wet bulb thermometer 25·3°; on the grass, 24·7°; whilst, if we turn to the internal temperature, we shall observe that *below* the surface—

At two inches on drained land it was	25·8°
At four ,, ,, ,,	22·3°
At six ,, ,, ,,	20·8°
At two inches on undrained land it was	22·8°
At four ,, ,, ,,	20·5°
At six ,, ,, ,,	20·8°

The ground and air were, therefore, in such a condition that the snow would not melt. At first the snow crystals were solid, opaque, rounded, and confused in the interior, yet exhibiting the usual six-sided or hexagonal form. Amongst these crystals Fig. 1 *a* was detected, resembling six small feathers fastened together, and presently another, Fig. 1 δ, not unlike an arrangement of fern fronds, having a central opaque star. From this time (10h. 15m. A.M.) the crystals were most beautiful. A third, somewhat similar to the last-mentioned, yet having the branches transparent and six-sided; then came a solid flat lozenge.

FIG. 1.



The next crystal is more especially worth notice, as it was changed artificially. It is represented in Fig. 2 *a*, fern-like at the tips, but feathered within in the manner of a fir branch, *quite opaque* and snowy white; on breathing gently on this crystal it partially melted, and froze again as a colourless *transparent* six-rayed star, Fig. 2 *β*, quite simple in its construction.

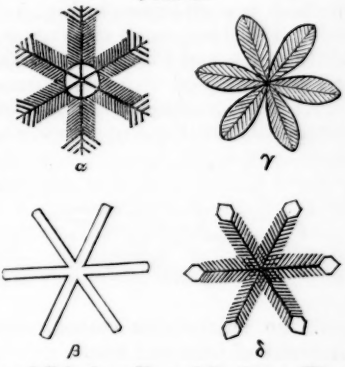
Fig. 1 *β* represents another star with spinose edges; there was also a crystal somewhat similar, in the form of a cuneate wheel, solid and opaque.

Fig. 2 *γ* was a leafy star, then came quite a different crystal from all the others, naked in its branches, but instead of being flat, it took the form of a ball.

Fig. 1 γ was the most remarkable crystal, in some respects not unlike the bloom of a marigold.

Fig. 2 δ was a feathery crystal, opaque, each branch hexagonal, and hollow.

FIG: 2.



At 11h. 50m. A.M., these crystals became mingled with very thin, transparent, and exceedingly small *needles of ice*, Fig. 3 *a*.

At noon, these needles fell briskly, and frequently two were united, mostly like Fig. 3 β.

At 12h. 5m. P.M., the needles had either assumed the form of feathers, Fig. 3 γ, or fell in bundles of feathers, Fig. 3 δ, and the crystals that now fell were much smaller, many of the size of Fig. 4 β, and some only just visible to the naked eye, like Fig. 4 γ. Before 11h. 50m. A.M., none were less than Fig. 4 *a*. The needles of ice when they first commenced falling were only equal in size to Fig. 4 δ, but soon became larger. The microscopic crystal, Fig. 4 γ, was just discernible as a minute circle, which, when magnified, resolved itself into a beautiful and complicated crystal.

FIG: 3.

In contrast to the microscope crystal, Fig. 4 γ, my brother (Capt. A. S. H. Lowe) sketched one at 11 A.M. on the 20th of February as large as a fourpenny-piece. This is represented, in Fig. 4 ϵ, of the natural size and form. I need not say this is a most unusual size, and more nearly approaches those described as seen in the polar regions by the arctic navigators.

FIG: 4

FIG: 5.

Returning to our present snow-storm, at 12h. 10m. P.M. the crystals were less in number, there

being now more needles, and feathers of ice in bundles, and amongst these were entangled one or more crystals, an example of which is represented in Fig. 5.

At 12h. 15m. small circular and conical opaque hailstones fell (Fig. 6 *a* and Fig. 6 β), which soon became very abundant, and were mingled with a few transparent bars of ice, Fig 6 δ.

At 12h. 35m. these hailstones were granulated, and had a double hexagonal form (Fig. 6 γ), which, when pressed with a hard pencil, broke into fragments, each fragment resembling the hailstone, Fig. 6 β, the pointed ends being in the centre of the hailstones, and the broad ends on the circumference. At 12h. 40m. P.M. the snow-storm ceased, after having given so great a diversity of form and size.

FIG: 6.

To Mr. Glaisher we are indebted for many figures of remarkable snow crystals, which he has published in the *Transactions of the British Meteorological Society*. To Sir John Herschel we are also indebted for the plate in the new edition of the *Encyclopædia Britannica*. Two plates of my own sketching may also be found in the *Magazine of Natural Philosophy*, and recently (January 3rd) I had the gratification of observing *hexagonal crystals of hail*, an account of which will be found in the *Transactions of the British Meteorological Society*.

Snow crystals always contain *six* similar branches or sides, as the water crystallizes in hexagonals. These branches are not exactly alike, differing from each other as leaves on the same tree, yet bearing so strong a resemblance to one another, that if it were possible to separate the branches from a number of crystals, and mix them together, it would very readily be ascertained (through a microscope) which branches belonged to each crystal.

The severe winter of 1855 was peculiarly rich in exquisite snow crystals, especially on the 22nd, 23rd, and 26th of January, on the 3rd, 6th, and 12th of February, and on the 11th and 22nd of March.

It is not uncommon to see two or more crystals frozen together; and occasionally a shower will come on, in which the crystals are broken up and mutilated, remnants of crystals being found amongst the snow-flakes.

The large woolly-like snow-flake which speedily covers the ground is not the kind of shower in which to see snow-crystals; these large flakes usually fall at a temperature scarcely below the freezing point; as the cold increases, the size of the snow-flakes decrease, and usually, if snow falls from 26° to 30°,

crystals will be observed: colder than this, the deposit will only be as icy spiculæ, or needles of ice.

Until the scientific balloon experiments, it was generally thought that the snow crawled along the ground, whilst the hail was formed at a considerable altitude. As a contradiction to this, Mr. Glaisher has passed through snow-storms a mile above the earth. In winter, whilst in mountainous districts, snow-storms may be seen travelling amongst the valleys, without ascending the mountains; and although the mountains are more frequently covered than the valleys, it usually happens, from this circumstance, that whilst rain falls in the valley, the colder hills are receiving it in the form of snow.

It may be that the snow in winter is very close to the ground, ascending higher into the air the warmer the weather becomes.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY G. M. WHIPPLE.

1864.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively.		
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Jan. 1	29·996	33·1	21·7	·66	·137	34·9	32·9	2·0	9, 4, 5	NE by E, ENE, NE.	·149
„ 2	30·521	30·1	...	...	...	33·2	24·6	8·6	10, 10, 4	NNE, E, E by S.	·000
„ 3	...	...	...	...	...	32·6	23·2	9·4	...	...	·000
„ 4	30·527	27·9	20·7	·77	·132	31·3	21·5	9·8	3, 4, 2	NE, NE, NE.	·000
„ 5	30·314	28·4	22·3	·80	·140	31·8	25·6	6·2	10, 6, 8	NE, ENE, NE.	·000
„ 6	30·248	19·5	...	...	...	24·0	14·0	10·0	10, 9, 10	—, —, —.	·000
„ 7	30·202	20·8	19·2	·94	·125	28·2	12·2	16·0	9, 7, 10	—, SW, SW by S.	·000
„ 8	30·010	25·6	24·1	·95	·150	30·2	15·6	14·6	7, 10, 10	—, NE, NE.	·000
„ 9	29·924	34·6	33·6	·97	·211	39·5	18·4	21·1	10, 10, 10	E, NE by E, E by N.	·000
„ 10	...	...	...	...	...	45·1	31·5	13·6	...	... ...	·005
„ 11	30·120	40·0	35·2	·84	·223	47·1	33·2	13·9	6, 0, 0	SE, SE by E, SE by E.	·003
„ 12	30·115	39·7	37·0	·91	·238	41,7	35·6	6·1	7, 10, 10	SE, SE, E by S.	·000
„ 13	30·317	36·9	37·0	1·00	·238	38·1	36·9	1·2	10, 10, 10	NE by N, N, NE by N.	·136
„ 14	30·279	35·8	34·7	·96	·219	37·2	34·8	2·4	10, 10, 10	N, E, S by E.	·019
„ 15	30·292	32·9	32·0	·97	·199	34·6	29·2	5·4	10, 10, 10	E, E by N, E by N.	·000
„ 16	30·238	35·2	30·3	·84	·187	38·8	31·4	7·4	10, 9, 10	SE by E, SE by E, E by S.	·002
„ 17	...	...	...	...	...	40·9	32·0	8·9	...	... ...	·176
„ 18	30·114	41·7	41·8	1·00	·281	44·4	37·0	7·4	10, 10, 10	ENE, E by N, NE by N.	·008
„ 19	30·207	43·9	40·2	·88	·266	47·0	39·1	7·9	10, 7, 10	S, SSW, S.	·000
„ 20	30·237	44·5	43·1	·95	·294	47·7	41·5	6·3	10, 10, 10	S by W, S by W, S.	·185
„ 21	29·980	44·3	40·6	·88	·270	46·9	44·2	2·7	10, 7, 2	W, SW, SSW.	·044
„ 22	29·812	50·2	47·9	·93	·347	52·6	42·2	10·4	10, 10, 10	SSW, SW, SW by S.	·002
„ 23	29·842	47·6	41·7	·81	·280	50·2	49·3	0·9	10, 10, 10	SW, SW by W, SW by S.	·007
„ 24	...	...	...	...	...	45·4	34·0	11·4	...	... ...	·175
„ 25	30·435	40·4	39·6	·97	·260	43·4	30 9	12·5	10, 8, 10	SW by S, SSW, S.	·025
„ 26	30·231	40·6	34·7	·81	·219	43·9	37·6	6·3	0, 2, 1	SSW, SSW, SW by S.	·000
„ 27	30·004	48·3	44·2	·87	·305	51·5	36·3	15·2	10, 7, 10	SW by W, W by S, SW.	·017
„ 28	29·920	44·7	35·3	·72	·224	47·3	41·1	6·2	4, 10, 9	W by S, W, NW by W.	·000
„ 29	30·424	35·7	25·4	·69	·157	38·1	35·0	3·1	5, 6, 2	NE, E by N, NE by E.	·004
„ 30	30·470	34·6	29·4	·83	·181	38·5	22·0	16·5	10, 3, 2	SW, SSW, S by W.	·000
„ 31	...	...	...	...	...	41·3	25·6	15·7	...	... ...	
Monthly Means.	30·184	36·8	33·7	·81	·220	...	...	9·0	...	...	0·957

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—JANUARY, 1864.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																
12	27	13	2	8	8	5	1	2	3	7	5	7	3	6	4	11	16	4	6	16	25	25	30	4	7	3	15	19	13	1	1	9·6
A.M. 1	29	11	1	8	8	2	1	2	2	5	6	7	3	5	2	9	13	2	8	14	27	23	33	4	7	6	15	20	18	2	2	9·5
A.M. 2	28	15	2	9	7	2	1	2	7	6	6	8	4	5	1	15	15	0	7	12	22	20	33	3	6	5	15	19	17	1	1	9·5
A.M. 3	26	14	3	12	6	2	0	0	5	7	5	7	5	9	3	17	12	2	6	12	25	26	37	4	4	4	16	16	14	1	2	9·7
A.M. 4	31	12	2	13	12	2	0	1	6	6	7	11	3	6	9	17	14	2	5	13	26	27	36	4	4	5	16	20	13	1	2	10·5
A.M. 5	33	5	5	10	17	1	1	2	5	7	9	9	4	8	5	14	13	1	4	13	23	28	33	4	5	7	15	17	10	1	2	10·0
A.M. 6	30	8	9	8	18	1	1	1	5	10	5	8	3	5	7	15	15	5	2	12	21	27	31	3	5	7	18	18	13	2	8	10·4
A.M. 7	29	6	8	11	17	2	1	1	4	8	3	10	5	6	12	16	14	6	4	12	15	26	27	4	4	10	17	15	15	3	6	10·2
A.M. 8	26	6	6	9	14	1	1	0	5	6	5	10	6	1	8	14	9	5	6	12	12	29	21	5	3	11	11	12	15	6	6	9·1
A.M. 9	28	5	13	17	10	1	1	1	4	5	8	11	5	2	9	17	15	2	7	13	11	27	17	5	7	10	12	15	10	7	2	9·6
A.M. 10	34	11	14	16	9	1	4	1	4	5	9	8	6	3	6	15	...	2	11	15	11	29	15	10	8	15	14	19	13	10	5	10·7
A.M. 11	32	10	13	15	9	1	3	2	7	7	5	9	5	3	7	10	10	3	13	17	8	27	13	11	6	24	16	21	11	14	8	11·0
12	24	11	16	19	12	2	2	2	6	8	9	6	6	7	7	14	10	3	13	15	10	34	11	13	6	7	18	23	13	16	12	11·5
P.M. 1	30	8	15	20	11	1	3	5	7	9	13	6	5	6	10	14	10	5	14	18	12	32	12	12	7	9	18	22	8	15	12	11·9
P.M. 2	30	9	13	23	15	1	4	4	6	6	11	4	6	6	11	17	8	2	16	15	10	29	7	13	6	13	17	23	13	15	10	11·7
P.M. 3	32	8	20	18	15	2	2	3	7	7	9	6	7	5	9	15	9	3	15	16	9	30	6	10	4	13	15	23	14	11	8	11·3
P.M. 4	30	7	21	16	7	2	3	4	8	8	9	4	7	3	10	12	7	2	13	19	9	30	9	6	2	11	17	21	8	10	5	10·3
P.M. 5	23	2	28	13	3	1	1	2	10	5	7	3	3	2	11	13	3	1	14	22	11	24	11	6	3	8	16	21	4	6	4	9·1
P.M. 6	20	3	17	18	7	0	2	3	13	7	9	3	5	2	11	13	2	3	16	22	13	28	11	6	2	8	14	20	5	3	5	9·4
P.M. 7	19	3	13	17	6	0	2	3	11	6	10	4	7	2	10	17	1	5	17	20	11	28	16	9	4	6	16	17	5	5	3	9·5
P.M. 8	16	3	12	14	5	1	1	2	10	5	7	3	6	2	6	10	2	3	18	21	12	26	15	10	5	3	18	12	5	5	4	8·4
P.M. 9	17	3	10	20	3	1	2	3	9	6	8	3	8	2	6	13	1	6	14	21	19	25	13	9	4	7	21	13	5	2	1	8·9
P.M. 10	18	4	7	21	4	0	2	4	9	9	7	3	6	2	8	16	1	5	16	25	23	14	6	11	3	10	18	15	4	4	1	8·9
P.M. 11	17	2	8	14	2	2	1	4	6	6	7	4	7	1	8	15	1	8	14	25	25	26	5	8	3	16	18	9	1	5	1	8·7
12																																
Total Daily Movement.	629	179	258	349	225	34	40	54	159	161	179	154	125	99	180	339	201	80	259	400	390	640	448	174	115	218	386	430	247	146	111	9·9

ERRATUM.—In our February (1864) Number, p. 41, for Total Daily Movement on October 8 read 455 instead of 155.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1864.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M. respectively.		
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9.30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Feb. 1	30·205	40·2	35·5	·85	·225	45·4	25·0	20·4	3, 6, 10	S, WSW, SW by S.	·000
„ 2	30·146	45·2	43·1	·93	·294	50·0	36·1	13·9	10, 10, 10	SSW, SW, SW by S.	·010
„ 3	30·021	45·8	39·4	·80	·259	49·0	45·2	3·8	10, 10, 3	WSW, W by S, W by S.	·013
„ 4	30·203	36·7	28·5	·75	·176	41·4	32·6	8·8	0, 5, 2	W, N by W, NW by N.	·010
„ 5	30·244	33·0	27·1	·81	·167	36·8	27·0	9·8	0, 10, 8	N, N by W, NW by N.	·020
„ 6	30·135	31·4	28·5	·90	·176	35·3	30·1	5·2	4, 8, 2	NNW, N by E, N.	·000
„ 7	...	...	...	...	...	31·0	24·0	7·0	...	... ...	·000
„ 8	29·731	31·5	28·3	·89	·174	35·5	25·1	10·4	10, 6, 10	N by W, N, N by W.	·000
„ 9	29·602	30·6	26·1	·85	·161	36·4	21·6	14·8	6, 5, 7	SW, WNW, NW by W.	·000
„ 10	29·443	30·9	26·3	·85	·162	38·1	17·9	20·2	9, 1, 10	—, NNW, N.	·000
„ 11	29·809	33·0	29·0	·87	·179	35·4	22·4	13·0	10, 10, 10	WNW, W, WSW.	·000
„ 12	29·427	46·5	45·4	·96	·319	52·1	32·0	20·1	10, 10, 10	S, SW by W, WSW.	·317
„ 13	29·760	50·0	43·7	·81	·300	54·3	41·6	12·7	10, 10, 1	SW, SW by W, W by S.	·032
„ 14	...	...	...	...	...	50·3	36·4	13·9	...	... ...	·002
„ 15	29·881	46·3	45·1	·96	·315	50·0	41·6	8·4	10, 10, 10	SW by S, SW by S, SW.	·000
„ 16	29·753	43·9	37·8	·81	·244	49·9	44·8	5·1	10, 9, 4	SW by W, WNW, W by S.	·019
„ 17	30·039	36·8	30·2	·79	·187	43·0	33·1	9·9	4, 10, 10	NW, NNW, N.	·081
„ 18	30·227	32·6	26·9	·82	·166	37·7	30·2	7·5	6, 8, 4	N, E by S, NE by E.	·028
„ 19	30·314	27·8	25·1	·90	·155	31·3	28·4	2·9	9, 7, 9	NE, NE, NE.	·000
„ 20	29·965	26·4	20·7	·81	·132	29·6	23·6	6·0	6, 10, 9	NE, NE, NE by E.	·013
„ 21	...	...	...	...	...	31·8	26·0	5·8	...	... ...	·000
„ 22	29·868	29·9	28·8	·96	·178	33·7	28·7	5·0	10, 10, 10	NNW, — —.	·000
„ 23	29·930	31·1	29·3	·94	·181	34·4	23·7	10·7	10, 10, 3	NE, NE, NE.	·000
„ 24	29·960	33·7	26·8	·78	·165	37·1	25·1	12·0	6, 10, 10	NE, ENE, NE by E.	·000
„ 25	29·967	34·6	29·4	·83	·181	37·7	30·8	6·9	10, 10, 10	ENE, E by N, ENE.	·124
„ 26	29·942	35·1	35·0	1·00	·222	37·3	33·4	3·9	10, 10, 10	N by E, —, ENE.	·004
„ 27	29·743	36·3	36·4	1·00	·233	38·7	34·5	4·2	10, 10, 10	E by N, E, E.	·000
„ 28	...	...	...	...	...	49·2	36·0	13·2	...	... ...	·036
„ 29	29·628	41·3	41·0	·99	·274	44·6	38·5	6·1	10, 10, 10	E, NE, WSW.	·020
Monthly Means.	29·918	36·4	32·7	·87	·209	...	...	9·7	...	... ...	0·729

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—FEBRUARY, 1864.

Day.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	Hourly Means.
Hour.																															
12		1	18	28	11	7	14	9	5	3	1	9	11	10	10	14	15	8	7	21	11	12	6	1	4	15	13	9	12	19	10·5
A. M. 1		3	17	29	10	15	12	7	8	4	0	7	11	11	9	11	14	6	4	20	11	14	5	2	6	16	12	9	10	6	10·0
2			17	26	11	14	15	7	8	2	1	5	11	6	10	10	14	6	3	20	11	14	7	1	6	18	12	9	11	8	10·1
3			19	25	9	11	15	12	8	3	1	6	17	20	6	13	13	12	4	20	12	16	4	1	10	16	11	9	14	9	11·3
4			16	25	7	7	17	10	8	4	1	8	20	21	8	13	15	10	3	20	13	15	0	2	10	14	11	9	15	8	11·0
5			17	18	7	7	16	5	9	4	1	6	19	24	8	17	13	8	5	23	9	13	1	3	7	12	13	9	15	6	10·5
6		26	20	14	8	8	18	4	9	4	3	4	24	28	9	14	12	10	8	23	11	7	1	2	9	14	11	9	10	8	10·8
7			17	15	8	12	20	9	8	3	1	8	24	32	10	11	11	9	8	23	10	15	1	4	11	16	11	9	11	6	11·5
8			18	13	8	12	16	5	9	4	1	8	26	35	11	13	13	13	8	21	13	15	1	5	14	15	12	11	8	4	11·9
9			17	15	10	13	15	10	8	5	1	8	25	30	14	12	13	13	8	24	16	12	2	4	13	14	8	14	7	5	12·0
10		14	18	13	13	20	15	9	9	6	2	7	27	30	20	18	12	20	10	26	20	11	5	5	16	15	10	15	10	6	13·9
11		16	20	16	11	20	19	10	9	4	3	6	22	37	20	18	13	20	10	21	15	11	5	3	15	17	10	19	10	6	14·0
12		16	21	16	14	17	11	11	12	7	2	8		39	20	23	20	20	11	25	19	13	1	6	19	18	15	13	6	2	14·5
P. M. 1		15	25	16	13	20	16	11	9	6	2	8		38	20	20	23	20	12	22	17	14	5	7	21	22	11	16	5	2	14·9
2		15	26	15	14	18	17	10	9	9	7	8	96	32	19	17	21	18	12	21	20	11	2	8	22	23	12	16	4	4	14·6
3		12	24	15	9	18	15	10	4	7	9	3		32	20	17	22	17	7	21	16	12	2	10	19	18	12	13	7	4	13·4
4		11	25	14	6	17	11	9	6	7	10	3		25	23	17	18	15	20	23	19	13	1	10	19	18	12	14	8	8	13·7
5		9	24	11	5	15	13	3	3	4	6	4	12	16	19	14	15	9	15	21	17	14	1	7	17	17	11	14	5	3	11·2
6		13	27	10	5	15	13	2	5	4	7	4	12	17	16	20	15	4	18	16	17	10	1	9	20	14	9	13	6	1	11·1
7		15	25	12	7	15	9	2	3	5	9	7	9	19	20	18	13	7	10	17	15	9	2	7	21	14	9	9	5	2	10·9
8		18	21	8	8	15	11	4	2	3	10	5	10	16	19	18	14	5	10	14	15	7	1	6	16	12	8	8	5	1	10·0
9		16	19	15	7	16	12	5	5	4	10	7	5	13	23	16	11	8	14	12	15	8	2	5	16	13	8	6	6	2	10·3
10		18	23	11	8	19	10	4	3	4	11	8	9	13	13	17	11	7	15	12	15	7	1	7	15	12	9	10	13	3	10·6
11		17	24	9	8	16	10	3	4	1	8	7	11	10	12	16	6	6	15	14	14	8	0	5	15	11	8	10	16	3	9·9
12																															
Total Daily Movement.		235	498	389	217	347	340	171	163	107	107	154	401	554	359	377	347	271	237	480	351	281	57	120	341	374	258	273	219	126	11·7

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1864. Day of Month.	Reduced to mean of day. Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively. Proportion of Sky clouded.	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Mar. 1	29·823	42·2	40·3	·94	·267	49·2	29·6	19·6	10, 6, 8	SE by E, SSE, SSE.	·114
„ 2	29·788	36·3	36·8	1·00	·236	46·4	29·0	17·4	10, 10, 4	NE by N, S by E, N.	·010
„ 3	29·610	36·3	37·6	1·00	·243	40·8	32·7	8·1	10, 10, 10	ENE, ENE, ENE.	·000
„ 4	29·549	48·5	44·9	·88	·313	55·3	36·7	18·6	10, 7, 4	SW by S, SW, S.	·493
„ 5	29·367	40·8	41·9	1·00	·282	46·2	37·9	8·3	10, 10, 10	E by N, E by N, E by N.	·013
„ 6	...	...	...	...	...	52·8	39·5	13·3	...	...	·460
„ 7	29·041	45·0	39·0	·81	·255	50·6	40·6	10·0	10, 10, 9	SW by S, WSW, WSW.	·043
„ 8	29·139	38·5	37·4	·96	·241	45·1	41·9	3·2	10, 10, 10	N, NW, NE.	·165
„ 9	29·119	31·2	31·1	1·00	·193	34·7	33.9	0·8	10, 10, 10	N by W. N, N.	·240
„ 10	29·681	36·9	32·5	·86	·203	44·4	27·7	16·7	3, 5, 1	SW by S, SSW, SW.	·346
„ 11	29·555	44·6	37·0	·77	·238	50·9	35·3	15·6	7, 4, 2	SW, SW, WSW.	·065
„ 12	30·146	43·3	31·3	·66	·194	48·9	37·1	11·8	1, 5, 3	WSW, WNW, W.	·126
„ 13	...	...	...	...	...	51·3	35·3	16·0	...	...	·003
„ 14	30·031	47·8	40·9	·78	·273	54·7	43·1	11·6	10, 10, 7	WSW, W, W.	·000
„ 15	29·871	44·4	40·7	·88	·271	51·5	45·1	6·4	10, 10, 10	SW by W, WSW, N.	·020
„ 16	30·136	39·6	36·1	·88	·230	46·6	34·0	12·6	10, 2, 0	NE by N, E, E by S.	·050
„ 17	30·086	40·9	29·6	·67	·183	47·8	32·5	15·3	9, 8, 6	ESE, SE, E.	·000
„ 18	29·770	40·1	28·5	·66	·176	46·9	30·4	16·5	3, 3, 1	E, NE by E, E.	·000
„ 19	29·629	47·1	38·6	·75	·251	55·4	34·1	21·3	5, 2, 3	E, ENE, E.	·000
„ 20	...	...	...	...	...	56·9	31·9	25·0	...	...	·000
„ 21	29·647	41·0	37·0	·87	·238	49·4	35·5	13·9	10, 3, 4	NE, NE by E, E.	·000
„ 22	29·669	38·9	34·4	·85	·217	43·9	38·1	5·8	10, 10, 10	NE, NE, NE by N.	·000
„ 23	29·914	41·4	29·1	·65	·180	48·2	35·9	12·3	8, 6, 3	NE, NE, NE.	·005
„ 24	29·967	41·6	32·8	·73	·205	48·6	26·2	12·4	9, 7, 6	SSE, NW by N, ENE.	·000
„ 25	...	...	...	...	...	50·0	25·0	25·0	...	...	·000
„ 26	29·547	37·4	34·0	·88	·214	...	33·5	...	10, 10, 10	N, N, N by E.	·000
„ 27	...	...	...	...	...	45·7	30·8	14·9	...	...	·044
„ 28	29·285	42·8	33·3	·71	·209	46·8	35·4	11·4	7, 10, 9	NW by W, W, W by S.	·000
„ 29	29·352	38·9	31·2	·76	·194	47·1	34·0	13·1	10, 8, 1	NNW, N, WNW.	·162
„ 30	29·562	39·8	34·9	·84	·221	47·2	31·0	16·2	10, 9, 5	SW, NW, W by N.	·240
„ 31	20·751	44·7	41·1	·88	·274	50·9	31·0	19·9	6, 10, 9	SSW, SW, SW.	·034
Monthly Means.	29·655	41·2	35·8	·83	·231	...	...	13·8	...	... ...	2·640

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—March, 1864.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																
12	3	2	6	6	3	25	30	4	6	12	31	13	8	16	20	1	8	10	14	3	13	17	19	2	3	5	12	10	15	5	7	10·6
A.M. 1	4	3	8	4	3	25	28	4	8	11	24	17	8	17	25	0	8	8	8	6	11	14	18	3	2	3	11	9	15	4	6	10·2
2	5	4	11	2	4	25	22	6	11	10	21	15	6	16	25	0	10	8	6	4	14	14	16	1	3	4	12	10	16	6	6	10·1
3	6	5	12	2	8	23	19	7	9	8	20	12	7	22	25	1	11	6	8	4	16	17	19	1	2	4	13	7	16	6	6	10·4
4	8	5	13	9	8	17	21	11	9	9	22	12	5	21	26	3	13	8	7	5	17	14	21	1	2	8	12	10	19	5	8	11·3
5	7	4	13	4	6	14	20	9	12	8	22	17	8	21	24	7	13	6	8	7	15	15	17	1	3	6	8	9	20	2	6	10·7
6	8	5	17	2	14	15	18	5	9	7	24	14	8	17	19	5	12	8	7	6	20	13	20	2	3	4	10	9	21	5	5	10·7
7	9	9	18	4	12	12	17	7	13	8	28	15	8	18	20	4	11	8	11	6	20	10	21	1	4	9	15	12	23	2	5	11·6
8	9	6	17	7	14	8	25	7	14	8	29	18	11	21	25	2	14	14	11	8	19	15	23	1	2	10	18	16	25	1	7	13·0
9	5	9	20	2	19	4	30	5	11	13	28	15	17	16	21	7	15	16	15	10	25	14	20	3	3	11	22	20	24	3	13	14·0
10	10	8		5	17	10	25	5	12	17	30	19	23	18	20	14	13	21	20	15	23	16	20	4	1	13	22	22	24	5	20	15·7
11	10	8		10	16	21	28	12	11	21	25	29	23	23	21	14	16	22	16	23	17	17	22	3	4	14	20	19	27	5	20	17·2
12	9	4		14	15	24	32	12	12	28	35	20	23	21	19	26	27	21	15	25	24	18	22	3	3	14	18	21	28	8	21	18·7
P.M. 1	9	2	114	11	15	30	29	11	15	27	27	18	20	23	18	17	27	23	19	28	21	19	22	2	4	14	17	24	17	12	23	18·1
2	10	2		10	16	30	28	10	19	21	26	19	22	18	19	16	19	25	22	27	19	20	22	4	5	17	17	27	23	16	22	18·4
3	10	6		8	18	30	22	5	21	19	28	18	23	18	16	17	18	23	20	27	20	17	22	3	4	13	13	24	22	10	19	17·1
4	9	10		7	21	30	15	9	24	15	29	13	22	17	11	19	23	22	21	26	19	19	20	7	1	14	11	23	15	14	26	17·1
5	6	10	13	9	25	21	16	9	20	12	22	11	20	14	10	15	23	24	17	21	20	18	14	9	1	15	8	25	14	13	27	15·6
6	5	6	11	6	25	22	12	15	20	17	27	10	20	11	5	10	17	23	18	21	19	17	12	7	1	18	4	26	10	13	26	14·6
7	5	9	12	6	25	18	10	12	15	18	26	10	20	16	3	10	12	17	21	17	25	17	10	5	2	19	3	14	7	13	26	13·6
8	3	8	13	3	25	23	6	10	17	19	27	8	19	19	2	8	13	15	14	20	24	18	13	1	1	18	5	20	6	14	24	13·4
9	2	7	15	2	29	29	3	5	16	24	23	8	15	21	1	7	10	12	11	20	19	16	10	2	2	14	7	22	5	11	24	12·6
10	3	10	14	4	26	27	3	8	12	26	18	9	18	22	4	11	10	11	6	20	20	21	9	2	3	11	7	21	5	10	27	12·8
11	2	10	8	3	25	30	5	8	13	27	14	9	15	20	2	10	9	15	5	14	21	20	4	2	4	14	8	17	4	7	18	11·7
12																																
Total Daily Movement.	157	152	335	140	389	513	464	196	329	385	606	349	369	446	381	224	352	366	320	363	461	396	416	70	63	272	293	417	401	190	392	13·7

STAR-FOLLOWING WITH TABLE STANDS.

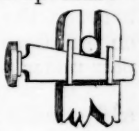
BY REV. E. L. BERTHON, M.A.

THE November number of the INTELLECTUAL OBSERVER contained a description of a new stand for astronomical telescopes likely to be acceptable to amateurs. The inventor wishes now to publish the sequel to that arrangement, showing a simple way by which the heavenly bodies may be conveniently followed, either, 1st, by a single movement of the one hand, or, 2nd, by a means entirely automatic. By referring to No. xxii. page 283, it will be observed that the movement in altitude is effected by a long screw turned by a little winch; and that in azimuth by a horizontal movement of the whole stand upon rollers.

It will be remembered that a slab of smooth slate, which may be had for three or four shillings, was recommended as the flat surface on which this stand should work. The slab should be about thirty inches long and eighteen inches wide, and instead of being fixed it should be made to revolve where required about a pivot. To accomplish the improved working of this stand, two pieces of wood cut this shape are fixed, one at each end of the slab, by means of a wedge. On the side of one of these pieces—that on the right hand—is placed a little sheave of brass working on a pin. Over this passes a piece of fine whipcord having a weight of three or four pounds upon it, and the other end made fast to the piece of wood on the other end of the slab. The cord is thus stretched across the slab in a state of tension.

We must now recur to the stand. The annexed woodcut represents, in real size, a section of the hinder part of the board or base: *a* is part of the long screw inclining upwards. This screw is prolonged backwards, and between its two bearings *b* and *c* it has a well-turned cone of boxwood, and terminates in a square end to receive the winch or handle *d*. The bearings *b* and *c* are prolonged upwards and support another spindle now to be described: it is made square between the bearings, and upon it is a flat wheel or disc of brass having its edge milled like that of a shilling, which is made to slide up and down the square spindle so as to touch the wooden cone at any desired part. On the same spindle behind the aftermost bearing is a brass sheave with several grooves of different diameters, *e*. There is also one more little sheave *f* working on a pin, round which and also round one of the grooves of the sheave *e*, is passed an elastic band to maintain a constant pressure between the cone and disc. Finally the

hinder bearing, *c*, is open like the letter u, so as to allow the spindle and disc to be raised clear of the cone; it is furnished with a little wedge which, when pushed in, lifts it up thus:—



Now to use this stand, the disc being kept free from touching the cone by means of the little wedge which is pushed in, the cord is passed completely round one of the grooves of the sheave *e* (either over or under according to the motion of the star to be observed). The stand is moved right or left by hand, and the altitude attained by the long screw. As soon as the star is found the little wedge is drawn back, and the disc is now pressed by the force of the elastic band against the cone, aided also by the weight at the end of the cord, and by the friction thus produced, the disc and cone now move together; thus the two movements in azimuth and altitude are simultaneously produced by turning the winch *d*; and their relative velocities are adjusted by sliding the disc to a larger or smaller part of the cone as required. Since there are several grades to the sheave *e*, and each may be acted upon by any part of the cone, a great variety of relative speeds may be obtained to suit the rising, southing, or setting of the heavenly bodies.

The above arrangement is found so simple and easy to work with, that any further degree of independence of manual action is unnecessary for the amateur astronomer on his own account, for with one gentle movement of one hand he can follow a star in any direction; but there are cases in which a complete automatic movement is desirable, as, for instance, in showing the planets to a number of young people one after another. The telescope once set may be kept with the object in the field for a quarter or half an hour by a very inexpensive mover, although hitherto such a luxury has been confined to the possessors of costly equatorial mountings, with equally expensive clockwork to keep them moving.

The prime mover to accomplish it is a plain *moderator lamp*, such as may be bought, without stand, globe, or chimney, for ten shillings. The wick-tube with the *smaller* rack and pinion is removed, and on the top of the little oil-pipe is soldered a very small gas-jet with stopcock, through which the oil may escape faster or slower as desired. The lamp filled with pure fine colza oil is attached to the slab of slate on the left-hand side and about a foot below it. Another pair of sheaves are now fitted, one to each of the blocks of wood on the slab; another piece of whipcord is used; one end of it is tied to the rack of the lamp which rises two or three inches when the lamp is wound up; it then passes over the two sheaves across the slab, and hangs down on the right side with another weight attached.

Now to employ this combination. Let the star be found as before, and the velocities in azimuth and altitude relatively adjusted; the cord from the moderator mover is now taken between the finger and thumb and passed round a small pin on the afterpart of the board or base of the stand, or it may pass under a little plate of brass and be nipped by a screw.

The lamp now takes charge of the whole affair, and slowly and steadily moves the stand towards the left, thus following the horizontal motion of the star or planet; but as the other *fixed* cord is passed round the sheave *e*, this movement cannot take place without turning it, and thus the vertical motion is obtained at the same time. The flow of oil is regulated by the stopcock; and if a greater force is required than that of the spring in the cylinder of the lamp, a weight of any amount can be placed on the top of the rack.

N.B. When the star to be observed is on or near the meridian no movement in altitude is required, so the little wedge is pushed in, and the disc revolving free from the cone, the winch may be transferred to the square above of the upper spindle.

SOLAR OBSERVATION.—TRANSITS OF JUPITER'S SATELLITES.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

THE most magnificent object of all human contemplation is, beyond a doubt, the great star to whose influence our planetary system has been subordinated by its Creator. Other suns, there is reason to believe, may be superior to it in magnitude, or at least intrinsic splendour, but in a remoteness which even the velocity of light, that reaches us in about eight minutes from the sun, can only measure by intervals of whole years, their individual features are, and ever must remain, unknown to us. As it was recently remarked in a very interesting paper, with which our readers are familiar, "We never see the Stars." On the other hand, the distance of our own sun is such as to place him within reach of even our smaller instruments, and to bring that enormous flood of light clearly before the spectator's eye;* while the magnitude, the variety, and the strangeness of

* A power of 180 represents the solar disc under so great an angle that its entire breadth, if it were comprised in one field, would fill up the whole sky from the horizon to the zenith. This may appear at first sight almost incredible, but it is matter of easy proof. The sun's diameter averaging a little more than half a degree, 180 suns, or one sun magnified that number of times, would occupy a space of upwards of 90°. This may serve to show how fallacious may be the judgment of our sight in the absence of any known object of comparison.

his phænomena, are such as to invite our most attentive inquiry. To this inquiry peculiar importance has been given of late years by the discovery of an apparent connection between the physical changes in the sun's surface and the electrical condition of the earth, as shown by magnetic variation; and a field has thus been opened for the most remarkable investigations. Such researches require, indeed, a great amount of perseverance. It was not till after twelve years of incessant attention that the celebrated German observer, Schwabe, succeeded in convincing himself of the existence of that periodicity in the development of spots which seems to stand in such mysterious balance with the electrical state of the earth, and, therefore, in all probability, with the conditions of vegetable and animal existence. His investigations were subsequently continued through nineteen subsequent years, and in all, for thirty years, as the President of the Astronomical Society said, in presenting to him their gold medal, never did the sun exhibit his disc above the horizon of Dessau without being confronted by Schwabe's imperturbable telescope, and that appears to have happened about three hundred days in a year. Nor was that other important discovery of the currents by which the spots are so frequently caused to drift from their places achieved by our own observer, Carrington, without a great expenditure of time and patience. On the other hand, the student who is disposed to explore this region of mysteries may remember, for his comfort, that his inquiries will be greatly favoured by the number of available hours during which the object is in sight, as contrasted with the short time allowed for nocturnal observations without encroaching on the natural season of rest, and by the additional chances thus given of intervals of clear sky, as well as by the frequent occurrence of very distinct vision through an amount of haze which would, in the case of less luminous bodies, be an absolute prohibition. This branch, too, of astronomical study bears a favourable comparison with some others of the highest interest—for instance, the determination of the periods of binary stars—in the inexpensiveness of the necessary apparatus, and the facility of observation, while a great stimulus to its prosecution may be derived from the opinion of so great an authority as Carrington. Four years of patient investigation have led him to the conclusion that "our knowledge of the sun's action is but fragmentary, and that the publication of speculations on the nature of his spots would be a very precarious venture." And, in referring to the designs of Schmidt, he says, "he believes that no observer will examine these delineations without finding many characteristic features not satisfactorily explained by any existing theory of the origin and formation of the spots, and without a conviction of the neces-

sity of accumulating other equally excellent series for the future establishment of correct views of this mysterious phænomenon." Amateurs, again, who have not the opportunity, or the inclination to take up the inquiry in a regular and consecutive manner, may yet find it most interesting as an occasional pursuit. Nothing, assuredly, is more grand than the telescopic aspect of that huge incandescent globe; nothing more marvellous than the dark gulfs which interrupt the continuity of its blaze; nothing more surprising than their rapid and almost incessant transformation. These are wonders, indeed, with regard to which, as in the instance of comets, the absence of analogy leads us almost to despair of any adequate explanation; yet this does not detract from the curiosity always attendant upon such gigantic displays of ever-active energy; and at the present time the subject receives an addition of interest from the discussion which has been carried on among some of our first observers, as to the exact form and distribution of certain peculiarities in the luminous surface. For many reasons, therefore, the subject is one with which amateurs may be desirous of becoming practically acquainted.

The study is, however, not to be entered upon without due caution. There is no other branch of astronomy in which any evil result is to be apprehended for a sight of ordinary strength; but the sun cannot, of course, be contemplated directly through the telescope without the risk of destruction to the eye; and even a degree of protection which might be deemed adequate by an inexperienced beginner may prove insufficient to prevent bad consequences. It has been stated that want of caution in this respect was the origin of Galileo's blindness, and that Sir W. Herschel injured one eye from the same cause. We cannot therefore begin our remarks more appropriately than by giving our readers some hints which may enable them to regard this ocean of flame with safety and comfort.

Few persons have such an eagle eye as to be able to fix their sight straight upon the noon-day sun; but there is no reason to think that those who can do so are sufferers from it, though even in this case a lengthened gaze might not be desirable. But matters are very different as it regards telescopic vision. In this, there is not only a great concentration of intensity, a large proportion of the rays collected by the object-glass being poured into the pupil of the eye; but an enlargement of angle, by which the mere luminous point representing the sun upon the unaided retina is expanded into a broad glaring disc. The impression of excessive light alone must be expected to be prejudicial to an organ not originally adapted for such excitement; but that of concentrated heat is probably still more

injurious. The object-glass of a telescope is, in fact, a burning-glass, and though its comparatively long focus, from the enlargement of the image, disqualifies it from producing the most powerful heating effect in proportion to its area, yet its energy in this way is not to be trifled with. A remarkable instance is given by Secchi of the activity of a $9\frac{6}{10}$ inch object-glass in the pure sky of Rome. Without any further concentration of the cone of rays than was due to the field lens of an eye-piece, a piece of the whitest paper exploded in the focus instantaneously like gunpowder, and 3 *grammes* (= 46·3 grains) of lead were melted in less than two seconds. Various schemes have been devised at different times to obviate the danger from this source. The most natural one, that of contracting the aperture of the telescope to very small dimensions, is not so successful as might perhaps have been expected, since, for reasons which involve a knowledge of mathematical optics, the focal image becomes less defined in proportion to the acuteness of the angle at which the intersection of the rays takes place. Herschel I., therefore, in older times, and Dawes in these, not to mention other observers, have pronounced in favour of using the largest available aperture; and the latter has remarked that the solar phænomena, "when carefully scrutinized with large apertures and high powers under suitable atmospheric circumstances, are so wonderfully different in their appearance from those presented by the diminished apertures formerly and necessarily in use, that it would not be very surprising if some observers, unaware of what had previously been seen and described, should imagine that the phænomena revealed by their newly acquired and powerful telescopes were really new discoveries." The excessive and perilous light and its attendant heat must therefore be all admitted first, and neutralized afterwards, as best we can. This could not be well done by interposing any screen of dark-coloured glass in front of the object-glass, since it would be difficult to find a sufficiently homogeneous piece of the required diameter, or to work it to plane and parallel surfaces with due correctness.* It has commonly been introduced behind the eye-piece, and close to the eye, in which position its very small dimensions exempt it from the disadvantages which have been mentioned; but even there it is not pleasant in use, as preventing the eye from coming near enough to command the whole

* I have somewhere met with a suggestion, but do not now recollect where, as to the construction of a solar telescope by employing as an object-glass a single lens of deep-coloured glass; this, transmitting only rays of nearly the same refrangibility, would be sufficiently achromatic, but the uncompensated spherical aberration would render rather a long focus desirable. The idea is ingenious, and might be worth a trial.

of the field. To avoid this, the late Mr. Lawson, of Bath, who was the possessor of a very fine 7-inch achromatic by Dollond, presented by him, at the close of his life, to the Greenwich Naval School, introduced the screen between the object-glass and the focus, very near the latter, in which position, however, it frequently was cracked by the heat. This is, indeed, an accident to which these glasses are often liable. The most experienced of solar observers, Schwabe, speaks of it, though in his case the screen was probably placed, as usual, in the exterior brass cap; and he remarked that the occurrence took place most commonly in years, such as 1833 and 1843, when few spots were visible. In some measure this might certainly be due to the lower temperature of the spots themselves—a curious fact, which has been fully established by Secchi; but should their relative area be considered too small to produce such a result, it would tend at any rate to show that, contrary to the opinion of Sir W. Herschel, their development was concurrent with diminished energy in the calorific influence of the sun.

As we have to deal with heat as well as light, it is by no means immaterial by what means the darkening process is effected. It is generally known that the rays of heat are distinct from those of light, and being less refrangible than the latter, are co-incident for the most part with the red end of the spectrum, extending even considerably beyond its ordinary limits. Glass, therefore, which freely transmits rays of that colour, being equally permeable by the rays of heat, is peculiarly ill adapted for a screen; its frequent employment in the solar caps of the older telescopes may probably have been owing to the superior readiness with which it could be procured, of sufficient depth, transparency, and uniformity of tint; but its effect was distressing to the eye. Green would be far preferable, as intercepting the heat, but it is difficult to obtain it of a tinge sufficiently powerful to subdue the excessive light. Deep yellow has also been used, but nothing seems preferable to a dark bluish-grey, or neutral tint, which gives a beautiful and comparatively cool image. Combinations of colour have been found very effective. Since white light is composed of what artists call the three primary colours—red, yellow, and blue, and the two latter form green, it is obvious that a combination of red and green, provided the tints were carefully balanced in quality and intensity, would transmit white light, with very little heat, the calorific rays being intercepted by the green glass; and such screens are said to be very pleasant. Sir J. Herschel speaks highly of cobalt blue (the colour of finger-glasses) interposed between two thicknesses of green,

and purple and green have been used by others.* From the great convenience of being able to vary its intensity at pleasure, a thin wedge of coloured glass has been recommended, prevented from acting as a prism by a similar wedge of plain glass placed in contact with it the reverse way. A plain glass wedge between two tinted ones of red and green, each of half the angle of the colourless one, was used by the Astronomer Royal for the eclipse in 1851. Such combinations must, of course, be made to slide easily across the eye-hole, or be held in the hand during observation. To attain the object of variable intensity, the ancient plan of smoking a piece of glass succeeds as well as far more expensive contrivances; it is also said to intercept heat much more completely than its hue might have led us to expect; probably in consequence of the absorptive power of the carbon; a slip may be nicely graduated as to depth by a little care in smoking, but will require to be protected from accident by another piece of clear glass placed over it, and kept from touching it by interposed bits of paper. In the preference of tint, however, another consideration must be taken into account, which ought to influence our choice in delicate observations. There is reason to believe that some of the minuter solar details possess a decided colour, which would be acted upon more in proportion than white light, by a screen of such a hue as to neutralize their own. Delicate veils of a ruddy cast, for example, such as have been noticed by Secchi, might be rendered imperceptible by the non-transmission of their light through green glass, or even a combination into which it entered; while the general clearness of the rest of the image would give no intimation that such a defalcation had taken place; and instances are on record where the remarkable phænomena of a great solar eclipse have been considerably modified from this cause. It would therefore be advisable, when minute features are to be carefully scrutinized, to be prepared with glasses of various tints.

A strong reason for caution, however, when ordinary screen-glasses are employed, exists in the fact that different telescopes seem to have different foci for heat. Mr. Reade, in one instance, found the burning effect much the strongest a little way short of the solar focus, so that the calorific rays diverged, while those of light emerged parallel from the eye-piece; and hence he recommended an eye-hole, like that of a Gregorian reflector, between the eye-lens and the screen-glass, to intercept the heat; by which means he found that an aperture of six inches could be used with safety. On the other hand, a

* It is a curious fact that this mode of observation with two differently stained glasses was anticipated, before the invention of the telescope, by Fabricius, in the solar eclipse of 1590.

case has been given of one eye-piece alone, out of a set, producing such a focus of vehement heat just at the front of the screen-glass, as partially to fuse its surface in two minutes with only three inches of aperture. A closer position is said to have saved the glass; and we must *hope*, without injury to the eye.

Other methods of subduing the heat have been adopted with success. The elder Herschel made use of a filtered mixture of ink and water, enclosed between parallel pieces of glass. The late Mr. Cooper, of Markree Castle, Ireland, found that a glass "drum" containing alum-water was so effectual that he could employ his whole aperture of 13·3 inches,* using merely dark spectacles to subdue the glare; while, on the other hand, during the great eclipse of 1851, Lassell found that the free heat of only 2·55 inches, with a focus of 32·5 inches, broke the dark glasses "with most alarming rapidity." To avoid risk of this kind, he used the wise precaution of previously exposing them to artificial heat. An ingenious helioscope, in part suggested by Sir J. Herschel, but improved and actually constructed by Colonel Porro, in Paris, deserves especial mention. It is a modification of the Newtonian telescope, in which metallic specula are replaced by those of unsilvered glass. The large concave mirror of course transmits all but a very small proportion of the incident light; the second reflection takes place at the surface of a small plane mirror, or "flat," as it is technically called, which stands at the angle of complete polarization of light; while a third reflection is produced from another similar mirror connected with the eye-piece; or the latter may be furnished with a "Nicol prism;" by the rotation of either of which arrangements round the axis of the cone of rays, the light, already reduced to a very minute fraction,† may, as those who are acquainted with the mysteries of polarization will readily perceive, be further diminished to any required degree, and the employment of coloured glasses rendered needless, even with considerable apertures. This beautiful device has also the merit of great comparative cheapness, but the disadvantage of being nearly useless for other than solar observations, and we have no sufficient information as to its accuracy of definition.

* This great instrument, twenty-five feet in focal length, was, as far as I know, the largest specimen of the workmanship of the French optician, Cauchoix. Its purchase by the late possessor was the unintentional means of increasing the dimensions of the great achromatic at Poulkowa, as the Czar Nicholas, on learning its magnitude, was determined not to be outdone in a private observatory, and altered his original order for one upon a larger scale. It was employed at Markree chiefly in the formation of an extensive catalogue of stars, and was recently offered for sale in consequence of the proprietor's death.

† This and similar values are so differently stated in different places, even by high authorities, that I have not specified them. The question of the amount of light reflected at various angles of incidence seems still open to inquiry.

We shall postpone to another opportunity our remarks upon other expedients of still greater practical value.

TRANSITS OF JUPITER'S SATELLITES.

As the opposition of Jupiter takes place on the 12th, the shadows of the satellites will be seen during the month in close proximity to the bodies which cast them, varying, however, of course, in this respect, from perspective, in proportion to the distance of the satellite from its primary, and changing sides at the time of opposition. The transits at convenient hours will be the following:—May 1st. Shadow of I. passes off the disc at 11h. 8m., followed by the satellite at 11h. 24m. 4th. Shadow of III. enters at 9h. 31m., III. itself at 10h. 32m.; their departures being at 11h. 40m. and 12h. 15m. respectively. 5th. Shadow of II. goes off at 10h. 35m.; the satellite at 10h. 54m. 8th. Shadow of I. enters at 10h. 50m.; I. at 10h. 57m.; the departures being at 13h. 2m. and 13h. 7m. 12th. II. enters at 10h. 53m., 3s. after its shadow, and leaves at 13h. 9m., 2s. before it. If the planet were precisely in opposition, and also in its node (or passage across the ecliptic), at the time of a transit, the shadow would of course be invisible, being concealed by the body of the satellite. This curious coincidence can but seldom occur, but there will be an approximation to it on the present occasion, as the planet will be in opposition with less than 57′ of N. latitude.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

GEOLOGICAL SOCIETY.—*March* 23.

NEW FOSSILS FROM THE LINGULA FLAGS.—Mr. J. W. Salter described two new genera of Trilobites, and a new genus of sponge recently discovered by Mr. Hicks in the hitherto scanty fauna of the Primordial zone. He also remarked that the fauna of the Lingula flags shows an approximation, in some of its genera, to Lower Silurian forms, and some—the Shells and a Cystidean—are of genera common to both formations; but the Crustacea, which are the surest indices of the age of Palæozoic rocks, are entirely of distinct genera; and their evidence quite outweighs that of the other fossils. The Primordial zone is, moreover, in Britain separated from the Caradoc and Llandeilo beds by the whole of the Tremadoc group, which are, at least, 2000 feet thick.

April 13.

THE SILICEOUS SPRINGS IN THE NEVADA TERRITORY.—Mr. W. P. Blake communicated a description of the physical features of this

elevated semi-desert region, which is composed of a series of longitudinal mountain ranges with alternating valleys and plains. The most abundant rocks are those belonging to the Igneous and Metamorphic groups; but Carboniferous limestone and Tertiary strata are also found.

The siliceous hot springs extend for some considerable distance along a line of fissure in a granitic rock, parallel to the mountain ranges. The water of these springs deposits silica in an amorphous and also in a granular form, sulphur also being deposited in the interstices of the siliceous deposit. These phenomena are interesting as illustrating the mode in which quartz veins are produced in fissures in other rocks, from the older strata to the more recent formations.

Mr. Blake also described the mineral veins of the district there occurring in porphyry. They yield metallic sulphurets, including those of silver, lead, copper, and iron, with a little native silver and gold, the veinstone being a friable quartz. The general direction of these veins is north and south, and the amount of gold yielded by them is more abundant near the surface than at greater depths.

THE RED ROCK AT HUNSTANTON.—Mr. Harry Sceley read a paper on the geological characters of this rock, in which its physical structure was first considered, and it was shown to be divisible into three beds, the uppermost of which is of a much lighter colour than the rest, the middle being concretionary in structure, and the lower sandy. These beds, with the overlying white sponge-bed, were considered to belong to one formation, and were termed the Hunstanton Rock; but the thin band of red chalk some distance above was considered, though of similar colour, to be quite distinct,* as also was the Carstone below. The author considered the lower part of the Carstone to be of the age of the Shanklin Sands; and as the Chalk is not unconformable to the Hunstanton Rock, he concluded that the latter could not be the Gault, but must be the Upper Greensand, —a conclusion which he afterwards showed was supported by the evidence of the fossils, and the occurrence of phosphate of lime.

The seam of soapy clay which separates the Hunstanton Rock from the chalk was supposed to have resulted from the disintegration of a portion of the former, the red colour of which the author endeavoured to show was due to Glauconite.

The upper part of the red rock of Speeton was thought to be possibly newer than that of Hunstanton, and perhaps to represent the time which elapsed between the formation of the latter and that of the band of red chalk.

LINNEAN SOCIETY.—*March* 27.

ON THE PHENOMENA OF VARIATION AS ILLUSTRATED BY THE MALAYAN PAPILIONIDÆ.—Mr. Wallace read a paper on this subject, in which he stated that the study of the Papilionidæ of the Malayan Archipelago was likely to illustrate the disputed subject of variation.

* An analysis of this remarkable mineral will be found in the INTELLECTUAL OBSERVER, vol. iii., p. 300.

Mr. Wallace considered that variation was by no means the simple fact that it has generally been regarded, but that it included the several phenomena of simple variability, of the existence of the same species in two or more forms, viz., Dimorphism or Polymorphism. Also, what may be termed local forms, and the consideration of sub-species and true species.

Simple variability, in which the offspring irregularly and, as it were, accidently differ from their parents, is of the same nature as that so characteristic of domestic animals,

Polymorphism or dimorphism differs from simple variability in the fact that the variations are more or less constant or regular. Thus, in the *Papilio Memnon* the males are always uniform both in form and colour, being bluish black. Some of the females resemble the males in shape, but are ashy-brown in colour. Others have wings with spoon-shaped tails, and marked with white. Either of these females will produce males and females of both forms, but it is remarkable that intermediate forms between these two varieties of females never occur.

Similar instances of polymorphism among the females occurs in the *Papilio pammon* and *P. ormenus.*

These phenomena of polymorphism may be illustrated by supposing an island inhabited by white men, with black, red, and yellow women, and that, even after many generations, the males born were all white, and the females indifferently red, yellow, and black, irrespective of the colours of their female parents. In many cases the difference between the polymorphic forms of the same animal is so great that they have been described as belonging to distinct species.

The influence of local causes, such as the presence or absence of particular enemies, tends to produce that remarkable variation known by the term Mimetic Analogy. For example, the butterflies of a group known as the Danaidæ have a peculiar scent, which renders them obnoxious to birds of prey, hence they are free from persecution.

If, in the course of the accidental variations to which all animals are subject, a Papilio resemble a Danais, even slightly, in form and colour, it will escape persecution more than if it had remained unchanged; and each succeeding generation, those Papilios most like the Danaidæ will be the most protected and the most likely to increase in numbers. This process will, therefore, gradually but certainly produce a constantly increasing likeness or mimetic analogy, until at last one insect can hardly be distinguished from the other except by a close examination of the structural peculiarities.

SOCIETY OF ARTS.—*April* 13.

New Method of Preserving Meat.—Dr. J. Morgan read a paper on a new method of preserving meat. According to this mode, the animals to be killed have an opening made in the chest, through which the heart is reached. Incisions are then made into the arterial and venous sides of this organ, and a stream of water, the force of which is obtained by its flowing from an elevated cis-

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tern, is allowed to pass into the arteries, thence through the capillaries, into the veins, and to escape by means of the orifice in the venous side of the heart; in this manner the entire blood is washed out of the body, after which a solution of salt and sugar is injected as a preservative liquid. Similar plans were the subjects of patents taken out more than twenty years since, and were not found to succeed in practice. The theoretical objections appear to be, firstly, that by washing the blood out of the capillaries, the nutritive power of the meat is very much lessened; and secondly, that the preservative effect of the plan proposed is very doubtful. The antiseptic effect of salt is in great part owing to its power of abstracting water; this is not possessed by brine. It was stated that the meat preserved by Dr. Morgan's process was, when packed in barrels for ship use, headed on with a great amount of dry salt; this would have the same effect as the salt used in the ordinary plan of salting, and would slowly abstract the juice of the flesh, and render the meat as dry and innutritious as the ordinary plan.

ROYAL INSTITUTION.—*April* 15.

Recent Discoveries respecting the Properties of Gun-cotton.—Professor Abel delivered a most interesting lecture on the preparation and properties of gun-cotton; the lecture included a description of those recently discovered modifications, dependent on mechanical aggregation, which have enabled gun-cotton to be introduced with success in warfare, and for blasting purposes.

After detailing the objections to gun-cotton as ordinarily manufactured, objections which have hitherto precluded its use in actual service, Prof. Abel explained the action of nitric acid on cotton. He showed that it has two distinct modes of operation. If the nitric acid be permitted to act at a high temperature, and in an energetic manner, the carbon and hydrogen of the cotton may be completely oxidized. When, however, the action is moderate, and the temperature kept low, the hydrogen only is assailed, and is removed in gradations, peroxide of nitrogen being substituted for it. When two atoms of hydrogen are removed, and two equivalents of peroxide of nitrogen substituted, xyloidine is produced. When three atoms of each are interchanged, trinitro-cellulose, or pure gun-cotton is the result—100 parts of cotton losing 1·85 of hydrogen, and receiving 85·12 of peroxide of nitrogen. Intermediate stages may also be brought about, as in the preparation of that variety of gun-cotton used in the formation of collodion.

The original directions of the discoverer, Schonbein, order the nitric acid employed to be mixed with strong sulphuric acid, but from want of the requisite precautions in the manufacture, the product was uncertain in properties, sometimes even exploding spontaneously. By the precautionary measures adopted in the Austrian army, these uncertainties have been obviated.

The cotton loosely spun into yarn is boiled in a weak solution of alkali, in order to remove more easily oxidized materials, whose presence interferes with the action of the nitric acid. After this washing

the cotton yarn is dried in a centrifugal drying machine, and immersed in a mixture of one part of nitric acid (specific gravity 1·5), and three parts of sulphuric acid. Contrary to the original directions of Schonbein, it is allowed to remain immersed for forty-eight hours, so as to secure uniformity of result. During this action great care is taken to prevent the temperature rising. The cotton is then washed in a stream of water for a period of time varying from one to three weeks, and is subsequently dried in the open air; during this stage of the manufacture, some experiments have been tried as to the effect of steeping it in a solution of soluble silica prepared by dialysis, apparently with satisfactory results.

The properties of gun-cotton as prepared by the Austrian process appear to be very uniform and certain. When loosely arranged it inflames at a temperature of about 300° Fahrenheit, burning without smoke, and without leaving any ash. Its rapidity of ignition is so great that it does not ignite gunpowder when laid on its surface and exploded. By pressing a thin edge, as that of a stout card, on the centre of a tuft, one portion may be ignited without the flame communicating to the other. When gun-cotton is twisted into a yarn, its rapidity of combustion is perceptibly diminished; by varying the degree and tightness of the twist, the exact rate of burning required for different purposes can be secured, from the explosive violence necessary to propel balls from cannon to the slow combustion desirable in a mining fuse. An explosive gun-cotton resolves itself into gases, which are themselves combustible in air, consequently when a flask of gun-cotton is burnt in an open glass vessel, a secondary flame is seen, caused by their combustion.

Although the combustion of gun-cotton does not depend on atmospheric oxygen, its mode of burning is remarkably affected by the character of the gases in which it is burnt; thus in carbonic acid it burns with a feeble flame; in hydrogen, with one still feebler; in a receiver exhausted to a vacuum of 3 inches, it burns with a very slow combustion without light. The conditions requisite to the rapid burning of gun-cotton are, that the gases produced by the combustion should communicate sufficient heat to the adjacent portions to carry on the combustion. Hence, in gases like hydrogen and coal-gas, whose conducting power is very great, the heat produced is carried away so rapidly that the cotton almost refuses to burn.

By heating a twisted yarn of gun-cotton gently, a very slow combustion may be produced, or the same effect may be caused by blowing a current of air on a yarn in rapid combustion. The ease with which different rates of these combustions may be alternated was very strikingly demonstrated by Prof. Abel, who, after producing the slow rate of burning in a horizontal yarn, caused the combustion to become instantaneous by raising it to the perpendicular position, with the inflamed part dependent. Also, after having produced rapid combustion in one end of a long yarn, he changed it into the slow combustion by blowing the flame away from the unconsumed cotton, and back again to the rapid burning by blowing the current in the opposite direction.

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NOTES AND MEMORANDA.

SCULPTURE OF THE REINDEER PERIOD IN CENTRAL FRANCE.—Messrs. Lartet and Christy have laid before the French Academy an account of their discoveries in the grotto of Eyzies, in the Arrondissement of Sarlat (part of ancient Perigord). They found bones, cinders, wrought flints, and implements of reindeer horn. They likewise came upon numerous fragments of a hard schistose rock, and on two slabs of the same material were profile engravings giving partial representations of animals. They believe these to be the first examples that have been obtained of this kind of art as practised by the men who were contemporary with the reindeer in France, and other temperate regions of Europe. At Langerie Basse they discovered another manufactory of arms and implements of reindeer horn, some of them ornamented with "elegant sculpture, and of workmanship quite astonishing, when the means of execution possessed by a people who had no metal tools is taken into consideration. At Eyzies they likewise found a bone whistle similar to one from Aurignac. Some of the bone implements from Langerie Basse were not merely engraved, but sculptured in relief. One represented a horse's head, and in another instance the handle of a weapon was carved into the representation of an entire animal. M. Vibrage adds divers reasons for believing in the antiquity of the human race; and after speaking of the weapon handle just mentioned, states that these early sculptors likewise reproduced the human form in the shape of an indecent idol, the materials for which seem to have been taken from the elephant."

COMPANION OF PROCYON.—Mr. Bird, whose success in constructing silvered glass telescopes has been described in a former number, states, in the *Astronomical Register*, that he has succeeded with his 12-inch instrument in resolving one little star in the same low-power field with Procyon into two stars 9.5 and 9.8 magnitude. Mr. Knott has also seen them with his fine refractor, and estimates their angle of position at about 200°.

COMMON ORIGIN OF COMETS IV. AND V. 1863.—M. B. Valz communicates to the French Academy his observations on these two comets. He shows that "their inclinations differ only 4°, and their nodes only 7°. The angle comprised between the planes of their orbits is 9°, and they arrive at the point of approximation of their orbits with equal velocities, and five days' interval. He remarks that in 1846 the comet of $6\frac{3}{4}$ years was seen to separate slowly in two parts, and their inclinations, orbits, nodes, and velocities experienced little alteration. In like manner he thinks comets iv. and v., 1863, may have had a common origin.

FAIRBAIRN ON IRON GIRDERS.—The *Proceedings of the Royal Society*, No. 61, contains a paper by Mr. Fairbairn on iron girders, in which numerous experiments are adduced. The conclusions arrived at are that "wrought iron girders of ordinary construction are not safe when submitted to violent disturbances equivalent to one-third of the weight that would break them. They, however, exhibit wonderful tenacity when subjected to the same treatment with one-fourth the load; and assuming, therefore, that an iron girder bridge will bear with this load 12,000,000 changes, it is clear that it would require 328 years, at the rate of 100 changes a day, before its security was affected. It would, however, be dangerous to risk a load of one-third the breaking weight upon bridges of this description, as, according to an experiment cited, the beam broke with 313,000; or a period of eight years, at the same rate as before, would be sufficient to break it." Mr. Fairbairn considers, however, that the beam had been injured by 3,000,000 previous changes, producing a gradual deterioration.

VARIATIONS IN DIFFLUGIAN RHIZOPODS.—Dr. Wallich has an elaborate paper in the *Annals of Natural History*, illustrated by very numerous drawings, showing varieties of structure in the tests of these creatures. His conclusion is that the "animal does not vary, but it modifies the architecture of its habitation, and the mineral material of which that habitation is in a great measure constructed, in obedience to local conditions, and in the manner best fitted to meet its requirements." A "species" of difflugia will, therefore, only be a variety,

capable of repetition under the very circumstances that determined the peculiarity of its habitation.

THE WILLOW LEAVES, OR RICE GRAINS, ON THE SUN.—In that useful journal of intercommunication between astronomers, the *Astronomical Register* for March, is a letter from Mr. Nasmyth, containing his original paper on the willow leaf shaped objects on the sun, the existence of which, except as rarities, has been doubted by some other able observers. Mr. Nasmyth says a telescope of very considerable power and defining capacity is necessary. Mr. Dawes has seen the mottled aspect of the solar surface with a $2\frac{1}{2}$-inch glass, and a power of 60. He finds, with a 6 or 8-inch telescope, and high powers, that the surface is chiefly composed of luminous masses of all shapes, imperfectly separated by rows of darker spots. Anything like Mr. Nasmyth's willow leaves he finds very rare, and only found in the vicinity of large spots in their penumbra. Mr. Nasmyth, in the letter alluded to, says they are scattered over the surface, and lie in all imaginable directions. He says he considers the penumbra to be a true secondary stratum of the luminous envelope revealed by the partial removal of the outer and luminous envelope. When a solar spot is mending up, he sees the willow leaves bridging it across. Mr. Dawes sees the spots under such circumstances bridged over by luminous masses like stray straws from a plat. Since the subject was discussed at the Astronomical Society some weeks ago, the objects in question have been seen at Greenwich with the great equatorial and a smaller instrument, the result being the confirmation of Mr. Nasmyth's statement, with a slight modification. The mottled appearance of the sun is now affirmed to be produced by a multitude of bodies like *rice grains*, rather than willow leaves.

NEW ANÆSTHETICS.—Dr. Georges has addressed a note to the French Academy detailing various experiments. He states that purified keresolene, obtained from petroleum oil, is a good anæsthetic, but requires the aid of heat. Brom-hydric ether he especially recommends as safer than choloroform, not easily inflamed, and having an exquisite odour.

HEARING OF CRUSTACEA. — M. Hensen has a paper on the auditory organ of the Decopods in the *Zeit. fur wiss. Zoologie*, xiii., 1863, an account of which will be found in the *Archives des Sciences*, No. 74. To show that these creatures are quick of hearing, he placed prawns, or shrimps, in a vessel of sea water, containing strychnine, which augments the reflex power of nervous centres. A slight noise then caused the animals to bound away. He states that different sounds cause different hairs, which are connected with the auditory cavity, to vibrate. A particular note will make one hair vibrate, while its neighbours remain quiet.

PRODUCTION OF OZONE BY AGITATION OF AIR.—M. C. Sainspierre informs the French Academy that he has ascertained that ozone is developed by the mechanical action of blowing machines and ventilators producing strong currents. This fact may in part account for the healthy action of winds, and should be viewed in connection with Mr. E. J. Lowe's paper in our last number.

OBTAINING PALATES OF MOLLUSCA.—Mr. T. W. Wonfor obligingly sends the following:—"If you have not heard from any other source of a simpler method of obtaining the palates of mollusca than that mentioned in the Rev. E. Rowe's paper, I would call your attention to a plan suggested by Mr. Hennah. I have tried it, and found it very simple and successful. It is to boil the head of the mollusk in liquor potassæ in a test tube, by which means all parts, with the exception of the palate, are destroyed. The palate may now be taken out, washed in distilled water, and mounted. Those who have tried the dissection of minute mollusca will find this a saving of time and patience. It is better to boil the potassæ in a hot-water bath."

SEEING VENUS AS A CRESCENT.—The recorded instances of this planet having been seen as a crescent with the naked eye are very few, and the following extract from Theodore Parker's journal adds an interesting case to the brief list:—"When twelve years old I once saw the crescent form of Venus with my naked eye. It amazed me. Nobody else could see it; father was not at home. Nobody knew that the planets exhibit this form. So I hunted after a book on astronomy, and

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got it from the schoolmaster, and found out the fact and its reason." This was at Lexington, U.S. It is probable that if persons with keen sight would watch their opportunities in exceptionally still and clear states of the air, the crescent of Venus might be more frequently seen. The minuteness of the object may not be so great a difficulty as the ordinary tendency of the atmosphere to blur definition.

THE 80TH PLANET.—This little object has been named Sappho by its discoverer, Mr. Pogson, of the Madras Observatory.

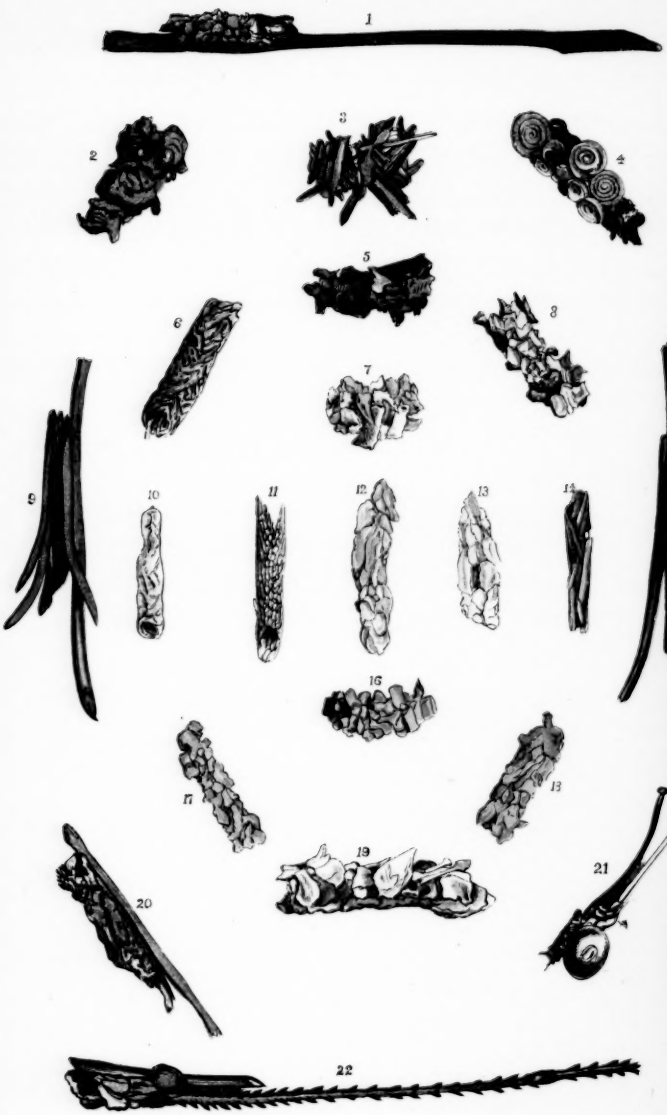
A STRANGE SURGICAL ACCIDENT.—*Cosmos* quotes from *l'Union Médicale* a strange story of an accident, resulting in the death of a woman sixty-three years of age, who was under M. Guèrin, at the Hôpital St. Louis. The patient suffered from luxation of the shoulder of three months' duration. She was placed under chloroform, and force steadily applied by four assistants, who worked some machinery (*les lacs contra-extenseur, and extenseur*), the precise nature of which is not explained. All of a sudden a dull sound was heard, and the poor woman's arm snapped off at the elbow. On examination it was found that the bones, muscles, and tissues possessed very little cohesion.

FLINT IMPLEMENTS FROM SYRIA.—The Duc de Luynes, accompanied by M. Louis Lartet, has obtained numerous flint implements, accompanied by the bones of herbivorous animals, from the caverns on the river Lycus, in Syria.

FECUNDITY IN CUBA.—M. Ramon de la Sagra communicates to the French Academy illustrations of the enormous families resulting from marriages in Cuba. In Trinidad, with a population of 14,463, ten couples had 13 children, one couple 24, two 21, one 18, one 16, and two 15. In St. Espiritu, with 12,850 population, fifteen marriages resulted in offspring to the extent of from 13 to 26 children, while in Villa-Clara, with 10,511 population, twelve happy pairs had produced 147 young ones. Many Cuban children become mothers at thirteen, and reappear in that character up to the age of fifty. M. de la Sagra compliments the Cuban ladies upon their extreme amiability, and fitness for all the duties of maternity; but, we fear, inquiry would show that there is very little intelligence among them, and that they lead the lives of well-fed, contented animals.

LARVAL REPRODUCTION IN INSECTS.—*Siebold and Kölliker's Zeitschrift*, for 1863, relates a curious discovery by Professor N. Wagner of some worm-like insect larvæ filled with smaller larvæ of the same kind. Except in the remarkable fact that the mothers are themselves only *larvæ*, these instances resemble the asexual reproduction of the aphides. The larvæ were obtained from under the bark of elms in Kasan, and appear to belong to some species of diptera. The *Archives des Sciences* remarks, "That amongst the asexual plant-lice the *pseudova*, or false eggs, are found in an organ which is the homologue of the ovary in the sexual individuals; whilst in the apodal larvæ observed by M. Wagner the pseudova are formed in the fatty body. This organ divides itself into a certain number of lobes, which surround each one with a special membrane."

OZONE AND ANTOZONE.—The *Archives des Sciences* for March contains an interesting account of the views of Clausius on oxygen. He considers that ordinary oxygen consists in atoms united two and two, and active oxygen in single, or disunited atoms. The two atoms which constitute a molecule of ordinary oxygen he regards in opposite electric states. Referring to M. Soret's opinions, M. Clausius observes that they coincide with his own, as his reasoning is not affected by the supposition that ozone is formed of elementary atoms not united in pairs, which may combine with molecules of non-decomposed oxygen as soon as they become free.



A. T. Elwes Del.

Cases of the Caddis Worm.